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HALLEY'S COMET

By Professor C. L. DOOLITTLE
THE FLOWER ASTRONOMICAL OBSERVATORY

IN what will be said in this connection respecting comets in general and Halley's comet in particular, it will not be necessary to occupy much space in repetition of the well-known series of ancient views respecting the physical nature of these bodies or the superstitious dread with which they were regarded. With reference to the latter phase of the subject it may be said in passing, that it was not altogether an unfortunate matter, as without this incentive, probably even such fragmentary and unsatisfactory records of comets as have come down to us would not have existed.

These accounts are very seldom of much service from a scientific point of view. Very few seem ever to have thought it worth while to measure the position of a comet, or to record anything that would help us to-day in the determination of its orbit, or in identifying it with earlier or later appearances. It was believed that they were meteoric in character, occurring like the aurora borealis only a few miles perhaps above the earth's surface, and subject to no uniform laws like the heavenly bodies. This applies to the western nations simply. We shall see that the Chinese were at least a little more rational in their methods, though little as to their ideas on this branch of astronomy is known.

There are, however, among the ancient writers, two whose utterances regarding comets are worthy of some attention, Diodorus Siculus and Seneca. The former wrote a voluminous universal history in which matters of authentic history are indiscriminately jumbled with myth and fiction, all apparently being considered of equal value. Among these, this statement occurs. "The ancient Egyptians and Chaldeans derived from long series of observations, methods for predicting the appearance of comets." As earthquakes and hurricanes were also occurrences which they were said to be able to predict, it seems to be the

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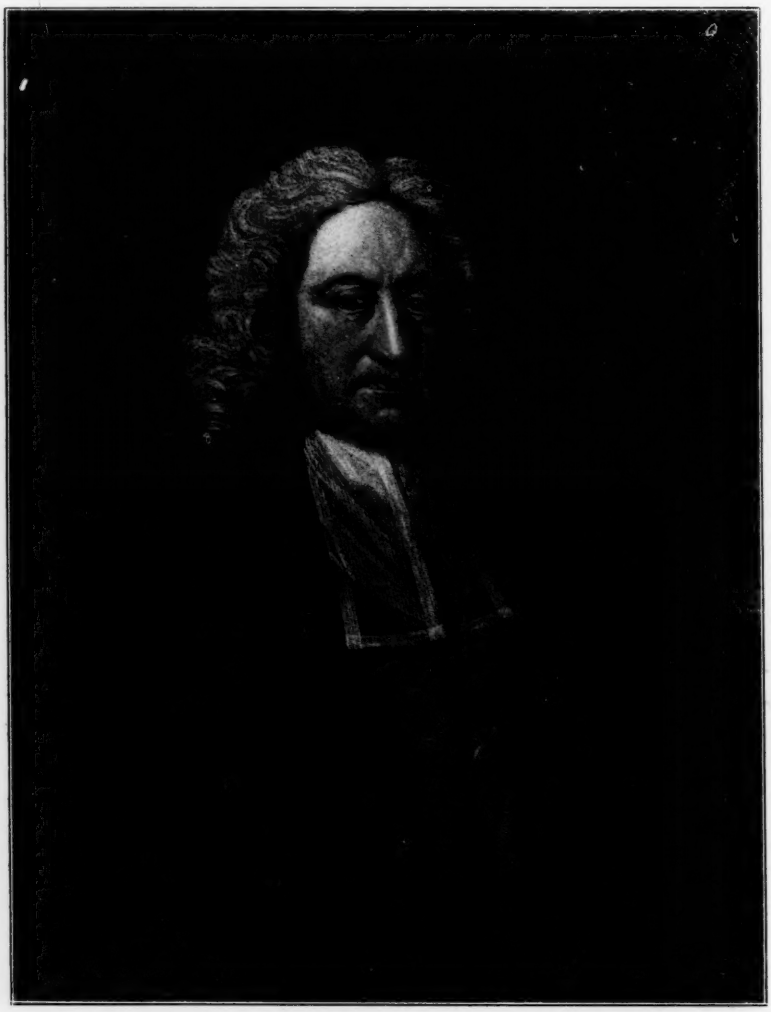
usual custom to dismiss the entire matter as belonging to the realm of astrology or myth, especially as nothing is said regarding the system employed. This would seem, however, to be a somewhat arbitrary procedure in view of what we know of their methods and results in other problems. It is well known that by comparison of long series of eclipses, these ancient people were able to predict their occurrence by



EDMUND HALLEY.

means of the cycle of 6,585 and one third days, or 18 years 11 and one third, or 10 and one third days, depending on whether the particular cycle included four or five leap years. It appears also, from comparatively recent investigation, that the same methods were employed in the planetary motions, and with success. It seems, then, a very natural

method of procedure to attempt to find similar cycles for other natural phenomena.

In view of the apparent facility with which the cycles, real or imaginary, can be discovered by those who have a taste for such investigations, we can readily believe that the occurrences referred to were thought to fall into line, and that predictions for the future may have been attempted. It is well to remember, in this connection, that no inconsiderable part of the science of to-day is in a similar empirical status. I need only to mention the sun-spot cycle, or cycles of which there are two or three, more or less fully established, and which depend wholly upon observation. Regarding the underlying causes, we perhaps know as little as the Babylonians did of the nature of comets. The numerous attempts which are still made to fit the various phenomena of the weather into some such orderly scheme are not all confined to the ranks of the ignorant and mentally unbalanced.

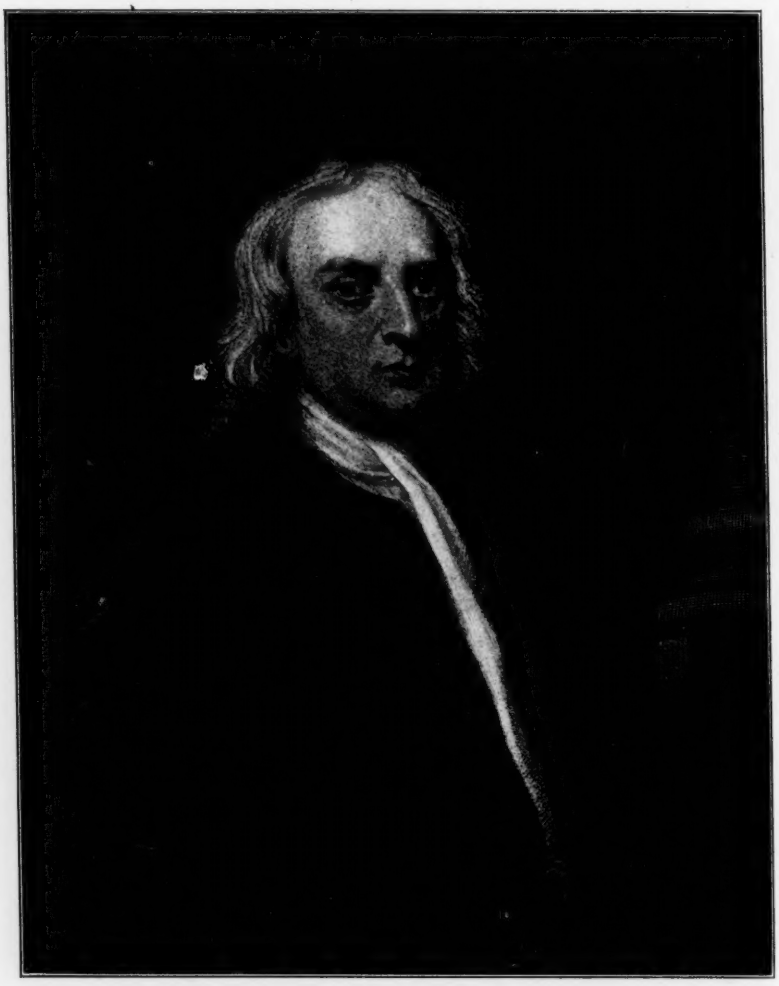
The second writer alluded to, viz., Seneca, makes, what was for his time, this remarkable statement:

> Why should we be surprised that comets, phenomena so seldom presented to the world, are for us not yet submitted to fixed laws, and that it is still unknown from whence come and where remain these bodies whose return takes place only at immense intervals? Fifteen centuries have not elapsed since
>
> Greece counted the stars by their names.
>
> How many people at the present day know nothing of the heavens except their aspect, and can not tell why the moon is eclipsed and covered with darkness! We ourselves in this matter have but lately attained to certainty. An age will come when that which is mysterious for us will have been made clear by time and by the accumulated studies of centuries. For such researches the life of one man would not suffice were it wholly devoted to the examination of the heavens. How then should it be, when we so unequally divide these few years between study and vile pleasure? The time will come when our descendants will wonder that we were ignorant of things so simple. Some day there will arise a man who will demonstrate in what region of the heavens comets take their way; why they journey so far apart from other planets, what their size, their nature. Let us, then, be content with what is already known; let posterity also have its share of truth to discover.

It was during the middle ages that the wildest absurdities regarding comets prevailed. Their connection with plague, pestilence and famine, with battle and murder and sudden death seems to have been called in question by no one. With the dawn of the renaissance, more rational notions began to appear. At first slowly, as we might expect.

One of the first to take hold of the problem in something approaching a scientific fashion, was the renowned Tycho Brahe, 1546–1601. From observations of his own he proved that comets were heavenly bodies, certainly as distant as the moon, instead of mere atmospheric phenomena, as was commonly supposed. With regard to their orbits, however, he was far from the truth in supposing them circular. Kepler was not so fortunate here as in his planetary investigations, supposing

as he did that they moved in straight lines. Finally Dörfel, a clergyman of Plauen, upper Saxony, eighty years after the death of Tycho, proved by a graphic process that the orbit was parabolic. He knew nothing, however, of the physical causes underlying this motion, but shortly after this appeared the immortal "Principia" of Sir Isaac



Sir Isaac Newton.

Newton with his remarkable demonstration relating to the motion of bodies under the action of gravity, viz., that the orbit may be an ellipse, parabola or hyperbola. Thus comets took their true place as orderly members of the system, and the last reason, if any such ever existed, for the superstitious dread of previous times disappeared. Errors, however, die hard, and this particular form manifested the usual vitality, in fact, it has not even now entirely disappeared.

The "Principia" appeared in 1687. So far as the conclusions there reached apply to the subject before us, the labor of adapting the theoretical results to numerical form and applying them to the practical problem of orbit computation, fell to Edmund Halley.

Halley, a contemporary and friend of Newton, occupies a very prominent place in the history of astronomical and physical science. Among other important discoveries and researches, may be mentioned the long inequality of Jupiter and Saturn, the proper motions of the stars, the secular acceleration of the moon's motion, method of determining the solar parallax by observations of transits of Venus, researches on terrestrial magnetism, and his epoch-making work on the motions of comets.

HALLEY'S COMET.

No.	Observed Perihelion.	Authority.	Calculated Perihelion.	Authority.
(1)	11 B. C. Oct. 9, Jul	Hind	—	—
(2)	66 Jan. 26 "	"	—	—
(3)	141 March 29 "	"	—	—
(4)	218 April 6 "	"	—	—
(5)	295 April "	"	—	—
(6)	373 Beg. Nov. ? "	"	—	—
7	451 July 3 "	Laugier	—	—
(8)	530 Beg. Nov.? "	Hind	—	—
(9)	608 End Oct. ? "	"	—	—
(10)	684 Oct. "	"	—	—
11	760 June 11 "	Laugier	June 15	Crommelin–Cowell
12	837 March 1 "	Pingré	Feb. 25	" "
(13)	912 Beg. April "	Hind	July 19	" "
14	989 Sept. 12 "	Burckhard	Oct. 9	" "
15	1066 April 1 "	Hind	March 27	" "
16	1145 April 19 "	"	April 6	" "
17	1222 Aug. 22 "	Crommelin–Cowell	Sept. 10	" "
18	1301 Oct. 23 "	Hind	Oct. 26	" "
19	1378 Nov. 9 "	Laugier	—	—
20	1456 June 8 "	Pingré–Celoria	—	—
21	1531 Aug. 26 "	Halley	—	—
22	1607 Oct. 27 Greg.	"	Oct. 27	Lehmann
23	1682 Sept. 14 "	"	Sept. 15	"
24	1759 March 13 "	Various	March 13	Rosenberger
25	1835 Nov. 16 "	"	Nov. 15	Pontécoulant
26	1910		April 8	Crommelin–Cowell

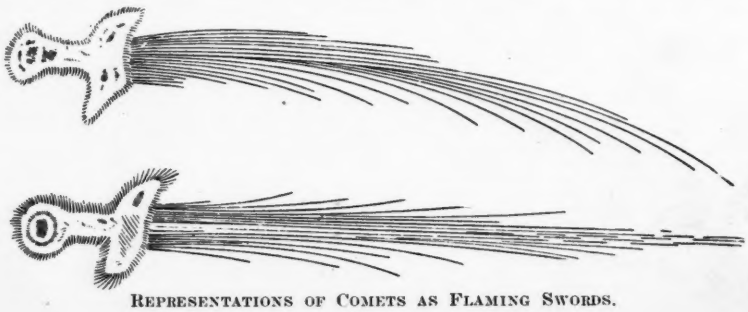
But perhaps Halley's most important work was the part which he took in the publication of the "Principia." It was largely through Halley's influence that Newton was persuaded to prepare this great work for publication, and entirely at his expense that the printing was finally done.

Among the contemporaries of Halley, we find many astronomers whose names have survived in history. We need only mention Flamsteed, the first astronomer royal, Cassini, Hevelius, Roemer and Huyghens. In his sixty-fourth year, Halley succeeded Flamsteed as astronomer royal and, at once, boldly set about the task of observing the moon through a complete revolution of the nodes, viz., a period of

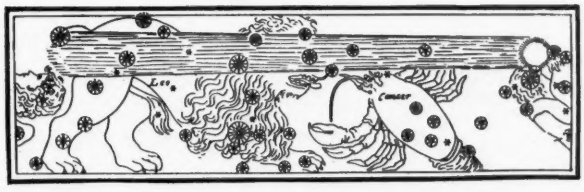
HALLEY'S COMET IN 1066 ON THE BAYEUX TAPESTRY.

eighteen years, for the purpose of improving the lunar theory, a problem which had long occupied much of his attention. He had the satisfaction of completing this eighteen-year task before his death, which occurred in 1742, his age being eighty-five.

Soon after the development of Newton's method, Halley set to work with the application to comets' orbits. Certain terms were tabulated in order to facilitate the application, but even with this aid Halley himself, who delighted in large undertakings, seems to have been greatly impressed with the magnitude of this one. The undertaking consisted in computing the parabolic orbits of all comets where sufficient data existed for this purpose, but, although the appearance of some four hundred of these bodies had been noted during historic times, only twelve had been sufficiently observed to give much hope of success. To this first twelve were afterwards added twelve more. The final results of this long investigation were not published until 1749, when it appeared with the title, "Synopsis Astronomiæ Cometæ." In these days, with improved methods of attacking the problem, such a task



REPRESENTATIONS OF COMETS AS FLAMING SWORDS.



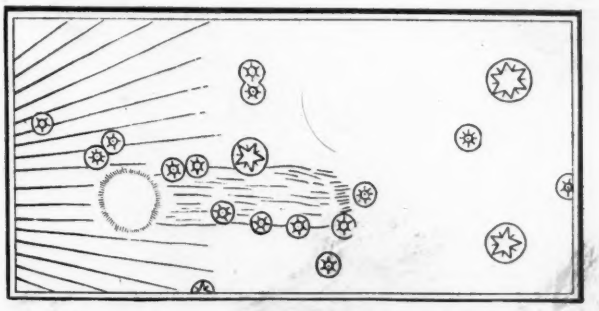
HALLEY'S COMET IN 1456 (according to Lubieniecki, Theatrum Cometicum).

would be very promptly disposed of. Of course, all computers are not like the late Professor Safford, who used to compute such an orbit in one hour, but we should probably not find it necessary to search long for one who would undertake to do the work in ten or twelve days. But the method developed by Newton seems now very cumbersome and its application laborious. It was, moreover, so far from comple-

TAILLESS COMET OF 684 (Halley?) in the Pleiades (according to Lubieniecki, Theatrum Cometicum).

tion that no means were found for computing the elliptic elements of a periodic comet unless it had been observed at a second return. The identification, therefore, depended on the similarity of the elements, a very uncertain criterion, as we shall see.

It is not at all improbable that if Halley had known more of the chances of failure which beset this method of identification he would hardly have ventured to predict another return of his comet. The step,



HALLEY'S COMET IN 1066, after its emergence from the Sun's Rays (according to Lubieniecki, Theatrum Cometicum).

in any case, was a bold one but, fortunately for Halley's reputation and for science, the result fully justified it.

The same process has been tried in many cases besides this one, but this seems to be the only instance where the prediction has been verified by success. Gibbon gives us a very interesting instance of this method of identification.[1] After referring to the remarks of Seneca, already quoted, he continues:

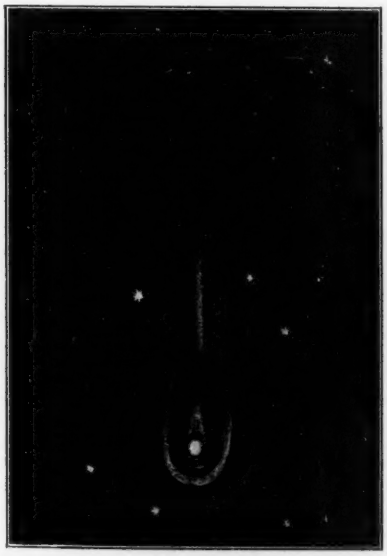
> Time and science have justified the conjectures and predictions of the Roman sage: the telescope has opened new worlds to the eyes of astronomers; and, in the narrow space of history and fable, one and the same comet is already found to have revisited the earth in seven equal revolutions of 575 years. The first, which ascends beyond the Christian era 1767 years, is coeval with Ogyges, the father of Grecian antiquity. And this appearance explains the tradition which Varro has preserved, that under his reign the planet Venus changed her color, size, figure and course; a prodigy without example either in past or succeeding ages. The second visit, in the year 1193, is darkly implied in the fable of Electra, the seventh of the Pleids, who have been reduced to six since the time of the Trojan war. That nymph, the wife of Dardanus was unable to support the ruin of her country: she abandoned the dances of her sister orbs, fled from the zodiac to the north pole, and obtained, from her dishevelled locks, the name of comet. The third period expires in the year 618, a date that exactly agrees with the tremendous comet of the Sibyl, and perhaps of Pliny, which arose in the west two generations before the reign of Cyrus. The fourth apparition, 44 years before the birth of Christ, is of all others the most splendid and important. After the death of Cæsar, a long-haired star was conspicuous to Rome and to the nations, during the games which were exhibited by young Octavian in honor of Venus and his uncle. The vulgar opinion that it conveyed to heaven the divine soul of the dictator, was cherished and consecrated by the piety of a statesman; while his secret superstition referred the comet to the glory of his own times. The fifth visit has already been ascribed to the fifth year of Justinian, which coincides with the 531st of the Christian era. And it may deserve notice that in this, as in the preceding instance, the comet was followed, though at a longer interval, by a remarkable paleness of the sun. The sixth return, in the year 1106, is recorded by the chronicles of Europe and China: and in the first fervor of the crusades, the Christians and Mahometans might surmise, with equal reason, that it portended the destruction of the infidels. The seventh phenomenon, of 1680, was presented to the eye of an enlightened age. The philosophy of Bayle dispelled a prejudice which Milton's muse had so recently adorned, that the comet from its "horrid hair shakes pestilence and war." Its road in the heaven was observed with exquisite skill by Flamsteed and Cassini: and the mathematical science of Bernoulli, Newton and Halley, investigated the laws of its revolutions. At the eighth period, in the year 2355, their calculations may perhaps be verified by the astronomers of some future capital in the Siberian or American wilderness.

In more recent times we have the remarkable group of bodies of which the comets of 1668, 1843, 1882 are members; there are others, the total number being probably very large. All of these bodies move in orbits almost identical, almost grazing the surface of the sun at the time of perihelion passage, and passing through millions of miles of the

[1] "Decline and Fall of the Roman Empire," Vol. IV., p. 289.

sun's corona. At the appearance of the 1882 member, it was fully believed by some prominent astronomers to be the same comet which had appeared in 1843, which was being rapidly drawn into the sun by the resistance encountered at perihelion passage. It appeared, however, that the orbit, derived exclusively from observations after that event, indicated a period of six hundred or seven hundred years, at least thus disposing of the question of identity. The behavior of the body itself was, however, very suggestive as to the true condition of things. After the close approach to the sun with its tremendous tidal strain, the nucleus was found to be broken up into a number of pieces. These parts, instead of approaching each other, separated more and more as long as the body could be kept in sight. At the next return, after some six hundred or seven hundred years, there will, no doubt, be four or five separate comets, following each other at intervals of perhaps a number of years.

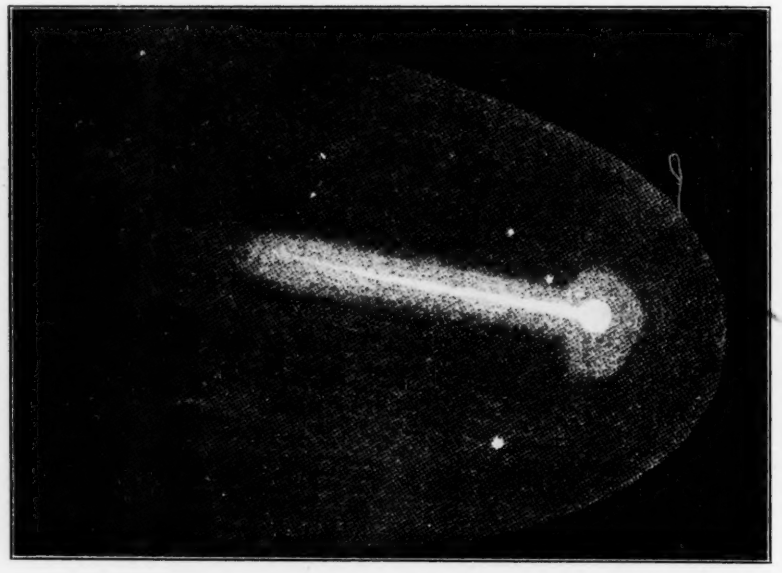
HALLEY'S COMET IN THE YEAR 1682.



HALLEY'S COMET IN THE YEAR 1759.

Halley confidently predicted the return of his comet in 1759. He also identified it as having been seen in 1305, 1380 and 1456. The difference of period, which amounted to one year and three months, was somewhat disturbing, but Halley assigned this to the true cause, namely, the perturbations produced by Jupiter and Saturn. He remarked that the period of the planet Saturn might vary as much as a month from the action of Jupiter. He says:

> How much more liable to derangement, then, is a comet, whose excursion into space is four times greater than that of Saturn, and whose orbit is so eccentric that if the velocity be increased the 1/120th of its value, the ellipse described the comet would be changed into a parabola.



HALLEY'S COMET IN 1835 (by Sir John Herschel).

As no method existed at that time for precise determinations of the perturbations, there was considerable uncertainty as to when to look for the next return, but Halley estimated that the general result would be a retardation, and that it would not be visible much before the beginning of 1759. This, as we shall see, proved to be a very fortunate guess.

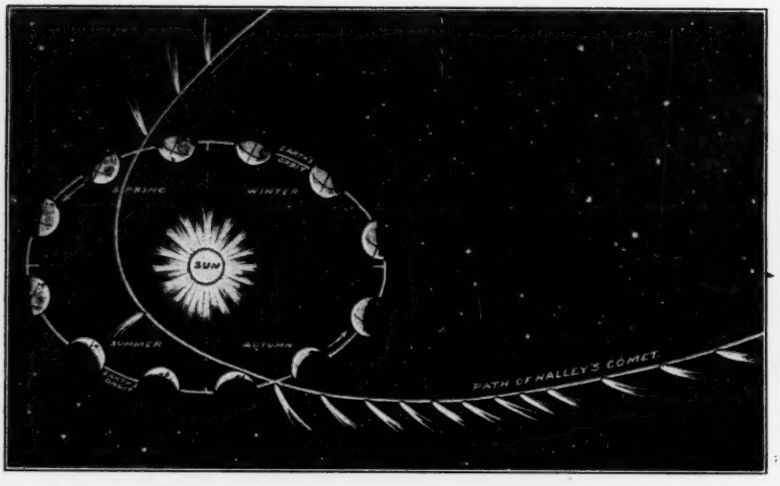
Naturally, the old chronicles were now diligently searched for records of earlier appearances. Beginning with 240 B.C., a continuous series of supposed appearances is found at an average interval of 76.8 years, but with the very considerable range of a little more than five years between the longest and shortest of these periods. With such a range, naturally, the period alone furnishes a very slight foundation for establishing identity, and, unfortunately, in many cases, the accounts given are so meager and unsatisfactory as to leave the matter in grave doubt. In a number of instances, where the comet has been connected with natural events, such as conjunctions of planets, eclipses, earthquakes and the like, or with important matters of history, the accounts may contain, in connection with much rubbish, sufficient material of value to leave no doubt as to identity. It has been thought by many that this is the comet mentioned by Josephus in connection with the destruction of Jerusalem. This would, perhaps, not be impossible, though a considerable stretching of the period would be required. The appearance in A.D. 451 is the first record which seems open to no doubt on the score of identity. In the autumn of that year the Huns, under Attila, were defeated by the Roman armies. Numer-

ous historians and chroniclers of that day agree that this event was announced by a comet, which proves to have been this one of Halley. To eclipses of the moon, April the second and September the twenty-sixth of this year, assist in fixing the date securely. The second of these eclipses is charged to the account of the comet itself. The return in 1066 has received much attention on account of its supposed connection with invasion of England by William, the Norman, and with the overthrow of Harold at Hastings.

By 1456 something more like scientific activity had begun. It was indeed nearly one hundred years before the publication of the immortal work of Copernicus, and astronomical observers were few and far between, particularly in Europe. In recent times a series of observations has been brought to light, made by Toscanelli in Florence. The discovery was made by Celoria, in 1885, and, as may be supposed, it is a most welcome addition to our data for fixing the exact circumstances of this appearance. Perhaps never before or after has a comet caused so much consternation as upon this occasion. Three years before, the Turks under Mahomet the second had taken Constantinople and their armies were pushing their conquests to the west. Many were apprehensive of the complete subjugation of Europe. Then a brilliant comet appeared, the precursor, as was supposed, of further calamities, and a universal panic seems to have taken possession of high and low alike. Who wonders if the pope ordered the church bells to be rung everywhere at noon, and that all should then engage in prayer for the protection against the Turks and the comet?

1531 is one of the dates used Halley in fixing the character of the orbit, the other two being 1607 and 1682. This appearance is known as the comet of Apian, that is, Petrus Apianus, alias Peter Bienewitz, court astronomer of Charles V., and of Ferdinand I. His observa-

HALLEY'S COMET (by Struve).



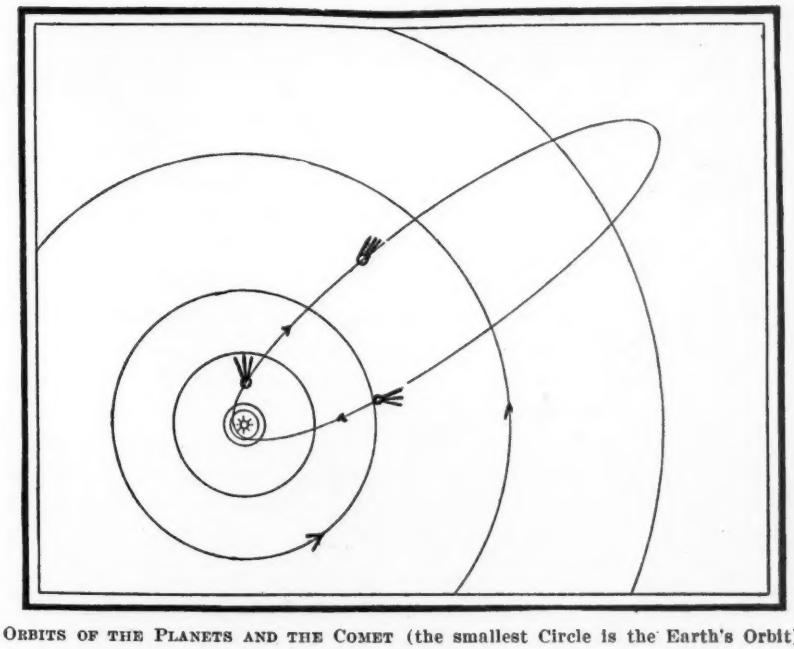
PATH OF HALLEY'S COMET.

tions extended for three or four weeks, and were made at Ingolstadt. Apian first established the fact that the comet's tail is constantly directed away from the sun. This was the first substantial item of evidence towards showing that comets, instead of being simply terrestrial phenomena, are in some way connected with the cosmic universe. The system of Copernicus had not then appeared, so the true solution of the problem could not be expected, though here at least was a beginning. Earthquakes, showers of blood and fiery appearances in the heavens are charged to this comet, but from now on, we have less and less of these matters. The next appearance, 1607, was detected by Kepler, though it had been seen a few days before by a monk in Swabia. Kepler furnishes a series of observations from September 26 to October 26, but he was less fortunate in his speculations regarding its nature and movements than had been his lot in his planetary researches.

The year 1682 brings us again to Halley. In these attempts to identify the early appearances, the Chinese annals have been of great assistance. In some cases all of the substantial evidence which we possess comes from this source. These records were kept in a much more systematic manner than the chronicles of the western people. The times when the comet was first and last seen are carefully recorded. The path, observed among the stars, is often given, not, of course, with extreme accuracy, but sufficiently so as to admit of the determination of an approximate orbit, and thus furnish valuable data for identification. The Chinese appear not to have been disturbed by the superstitious dread of comets which pervaded Europe. Their accounts of the physical characteristics are unsatisfactory, the length of tail and similar matters being given, not in angular, but in linear, measure, which, of course, means nothing.

Much was done, between 1682 and 1759, in the way of advancing the principles and methods of celestial mechanics. It was now possible, as it was not seventy-five years earlier, to determine the effect of the planetary perturbations and thus reduce to narrow limits the uncertainty as to the time of appearance. The matter does not seem to have been taken up seriously, however, until 1757, when Clairaut, who had already proved himself a brilliant mathematician, attacked the problem. Elaborate discussions of the problem of three bodies had already been developed, but they were not adapted to this case, on account of the great eccentricity of the orbit. This made it necessary to attack the problem in a very different manner from that employed in the case of the moon and the planets. Clairaut, however, proved himself equal to the task, though the practical application involved an immense amount of numerical work, and the time remaining was short. He was ably assisted, however, by Lalande, then a youth of seventeen, and a lady, Madame Lepaute.

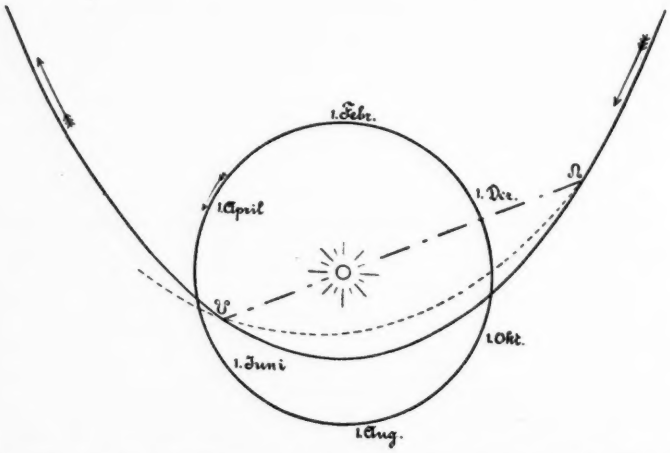
The final result indicates a retardation of 618 days, 518 being due to the action of Jupiter, 100 to Saturn. The time of perihelion passage was fixed at April 13, 1769, but, as it had been necessary for want of time to abridge the work, by omitting some small terms, Clairaut stated that the true time might differ from this by as much as a month. He states further that a body passing into regions so remote, and which is hidden from our view during such long periods, might be exposed to the action of forces, totally unknown, such as the



ORBITS OF THE PLANETS AND THE COMET (the smallest Circle is the Earth's Orbit).

attraction of other comets or even of some planet, too far removed from the sun to be even perceived. It should be remembered that nothing was known at this time of Uranus and Neptune. The actual time of perihelion passage was March 13, just within the limit.

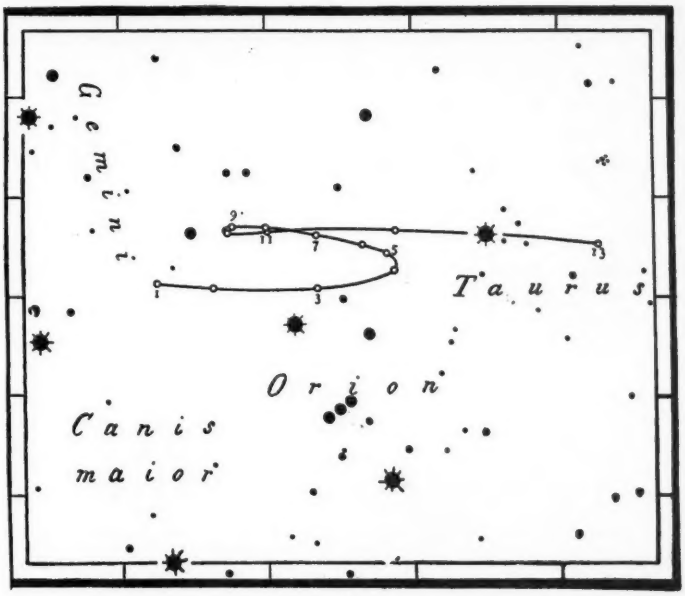
The history of its discovery is interesting. Though astronomers everywhere were looking forward with great interest to the event, the most elaborate attack was made at Paris. This was planned by De Lisle, but the work of searching for the body fell to Messier, whose name is familiar to astronomers everywhere in connection with the discovery of numerous comets, nebulæ and clusters. He had a genuine



THE PATH OF HALLEY'S COMET AND ITS CONJUNCTION WITH THE EARTH'S ORBIT.

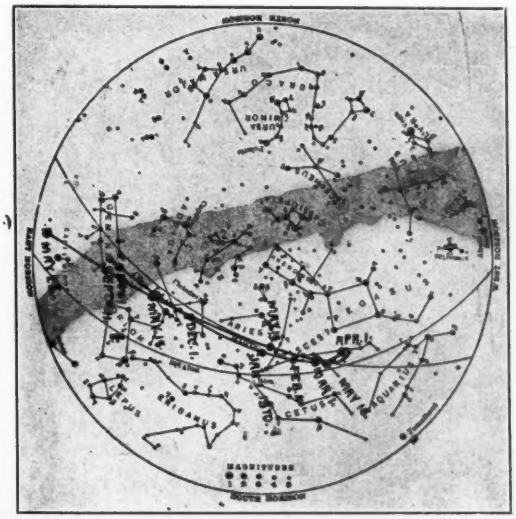
passion for this class of work, but no taste whatever for theoretical research. At this time he was living in the house of De Lisle, who seemed to think that he had a property right in Messier's observations, which Delambre tells us he hoarded as a miser does his wealth, neither using them himself nor allowing any one else to do so.

De Lisle planned a systematic siege of the stronghold. Assuming limits which he believed wide enough for the purpose, he prepared charts on which lines were drawn for convenient dates, the supposition being that the comet would be found somewhere on the line. Night after night for eighteen months, Messier carried on the siege until, finally, on January 21, 1759, he was rewarded with his first sight of the comet. It was doubtless humiliating to all concerned to learn that on Christmas eve, previous, the comet had been seen by a peasant named Palitzsch. Delambre states that he saw it with the naked eye, without previous knowledge of its existence, but this is not the true history. The account given by Palitzsch is quite different. He states that he was engaged in observing the variable star, Omicron Ceti, with his nine-foot tube, and that he found between Delta and Epsilon Ceti a nebu-



APPARENT ORBIT OF HALLEY'S COMET FROM OCTOBER 2, 1908, TO DECEMBER 7, 1909.
1908 (1) Oct. 2, (2) Nov. 25. 1909 (3) Jan. 15, (4) March 3, (5) April 15,
(6) May 25, (7) June 31, (8) Aug. 3, (9) Sept. 3, (10) Sept. 30,
(11) Oct. 26, (12) Nov. 17, (13) Dec. 7.

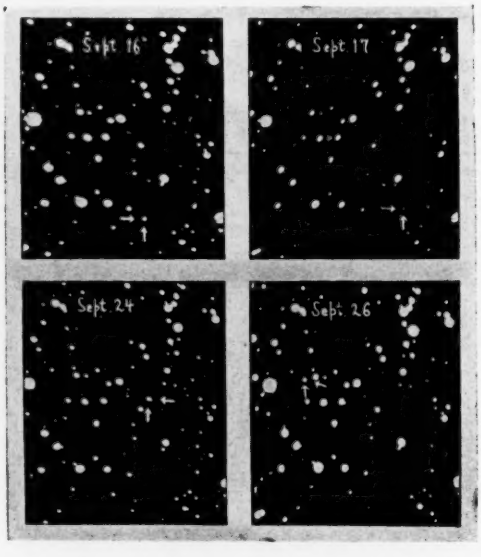
lous star which proved to be the comet. There were not wanting skeptics who doubted whether the comet would be found, but its return put an end forever to the old notions, and left no foothold for the opponents of Newton's theory of universal gravitation.



THE CONSTELLATION AT 9 P.M., DECEMBER 1, 1899.

The prediction for the next return was taken in hand, in due time, by no less than four distinguished mathematicians—Damoiseau, Pontécoulant, Lehmann and Rosenberger. These found, respectively, for the time of perhelion passage, 1835, November 4, 13–15, 26 and 12. This time the perturbations due to Uranus and the earth were included as well as those of Jupiter and Saturn. The actual time proved to be November 16.

Search for the comet began, on the part of numerous comet seekers, as early as January, 1835, but the first sight of it was obtained August 5, by Dumorchel, at Rome, very near the predicted place. About the middle of September, two months before perihelion, it became visible to the naked eye. The greatest brilliancy occurred about the middle of



HALLEY'S COMET AS PHOTOGRAPHED WITH THE TWO-FOOT REFLECTOR OF THE YERKES OBSERVATORY.

October. The public had been expecting something very striking, but, unfortunately, cloudy weather interfered to a great extent. It practically disappeared from the northern hemisphere with perihelion passage, but was followed for some time longer by Sir John Herschel at the Cape of Good Hope.

As regards the present appearance, the comet is already with us. The preliminary searching on this occasion has been greatly facilitated by photography, a resource not available on previous occasions. More than a year ago, as soon as this region of the sky had fairly emerged from the sun's rays, the campaign began at a number of observatories, in this country and Europe. The results were negative. Dr. Wolf, of Heidelberg has the honor of being the first to detect the comet on one

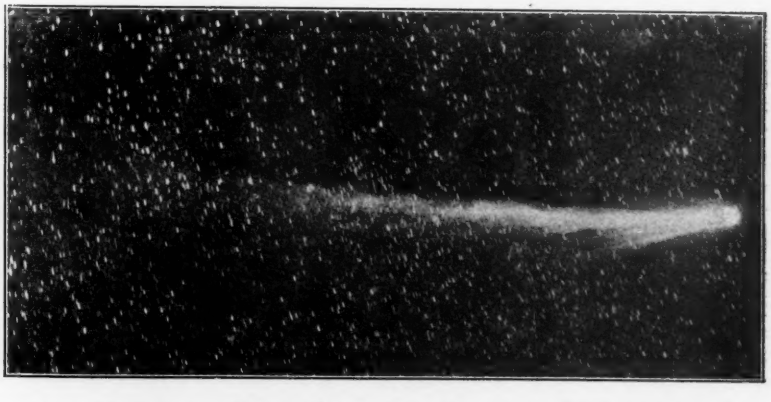
COMET MOREHOUSE, photographed at Lick Observatory, November 15, 1908.

of his plates, and is apparently the first who succeeded in photographing it. The first plate to show it was taken August 28, but he did not venture to announce it until September 11. At Greenwich two plates were taken September 9. At first nothing unusual was detected, but, after hearing of Dr. Wolf's discovery, a reexamination showed faint images on both plates. It has since been photographed and observed visually at several places. On the seventeenth the first view was obtained of it at the Flower Observatory.

The observed place differs from the computed one in right ascension 24^s, and $4'$ in declination, bringing the time of perihelion passage to April 20.0. Another result gives the time of perihelion, April 18.63.

The nearest approach to the earth will be in May 19, the distance about 14,000,000 miles. On May 18.14, Greenwich mean time, the earth and comet will be in heliocentric conjunction. It is not unlikely that on this date the earth will pass through the tail.

At the meeting of the Astronomical Society, 1908, a committee on comets was appointed, with the understanding that special attention



COMET MOREHOUSE, photographed at Lick Observatory, November 18, 1908.

should be given to this one. The plan which this committee hopes to carry out involves a constant watch of the comet, to be undertaken by a series of observers, so situated in latitude and longitude that the comet will never be lost sight of, except, of course, when it is in conjunction with the sun. A continuous series of photographs, taken in this way, on practically a uniform plan, will go far, it is hoped, toward the solution of some of the puzzling questions in connection with the physical behavior of these bodies, particularly with the rapid and peculiar change of the tail. The committee reports that good progress is being made towards carrying out their program. For the purpose of bridging the long interval between the Pacific coast and eastern Asia, Mr. Ellerman, of the Mount Wilson Observatory, expects to go to Honolulu early next spring.

THE DARWIN CELEBRATION AT CAMBRIDGE

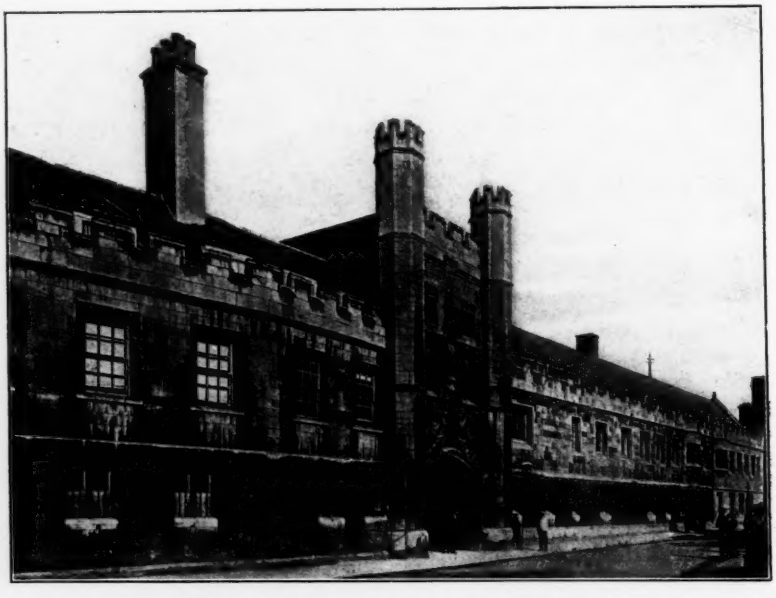
By Professor T. D. A. COCKERELL
UNIVERSITY OF COLORADO

THE Darwin Celebration, held by the University of Cambridge in June, was in every way a great success. So much has been printed concerning it that it hardly seems necessary in this place to go into many details; yet a brief account may be sufficiently interesting. The university did its part in the most magnificent way; indeed, so much entertainment was crowded into three days that the writer, who is not used to this sort of thing, was left rather bewildered. To see and meet some hundreds of people, any one of whom, encountered separately, would have furnished enough interest for the day, was like arriving in a strange country, where the fauna is all new and the pursuit of each rare object is interrupted by the sight of two or three others. This, however, was inevitable, and in spite of the complexity of the whole affair, there was apparently no serious hitch anywhere.

The delegates were both numerous and distinguished. According to the final list, which is understood to include only those actually present, there were twenty-five from the United States, not counting a couple of guests. Some of these were not biologists, but the list included many prominent workers, such as J. Mark Baldwin, J. Loeb, C. B. Davenport, E. L. Mark, E. B. Wilson, H. F. Osborn, W. B. Scott, C. D. Walcott, L. O. Howard, etc. Philadelphia did not send a single delegate of its own, though Professor Osborn, of New York, represented the American Philosophical Society. Harvard University and the Boston Society of Natural History had only one delegate between them. In general, however, the response from this country was highly creditable, considering the difficulty and expense involved, and the later, though in a certain sense rival, meeting at Winnipeg. Practically every country which makes any pretense to do biological work was represented, but some much better than others. Sweden sent eight delegates, including Nathorst and Arrhenius; Switzerland five, Holland six; but Norway only one, while Spain and Greece were represented solely by Englishmen. Germany, France and Austria had of course numerous and distinguished representatives. At the great reception by the chancellor of the university in the Fitzwilliam Museum, and again at the presentation of addresses, we marveled to see the splendor of the various academic gowns and hats, the men on these occasions really outshining the other sex in the conspicuousness,

if not the beauty, of their attire. Two nations only, the Swiss and the Japanese, wore plain black clothes. Chancellors of English universities are usually noblemen of no particular distinction intellectually; but most fortunately and appropriately, the present official head of the University of Cambridge is Lord Rayleigh, himself a scientific worker of the highest rank. In this, and also in the person of Professor A. C. Seward, who was the official more immediately in contact with the delegates, Cambridge was happy in being represented by scientific eminence no less than academic distinction.

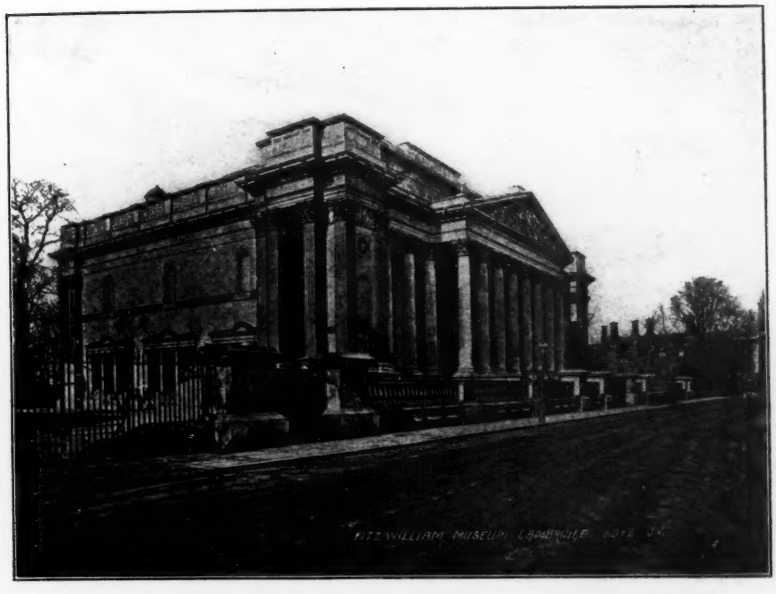
At Christ's College, where Darwin was in residence some eighty years ago, there was an exhibition of objects connected with his life.



CHRIST'S COLLEGE, where Darwin attended from 1828 to 1831.

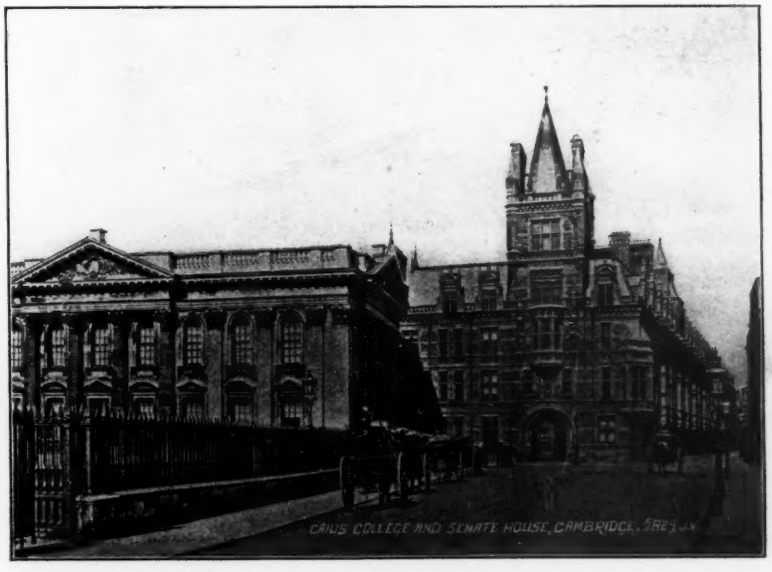
This included many manuscripts, the apparatus he used upon the voyage of the "Beagle," specimens he collected, numerous portraits, etc. There was even a series of contemporary caricatures, some good-natured, some otherwise. One represented a monkey with a face more or less like that of Darwin, sitting in a tree, reading the "Origin of Species." "Here," ran the legend, "but for natural selection and the survival of the fittest, sits Charles Darwin."

As we were looking at these things, Dr. Francis Darwin came in, leading an old man. My heart stood still for a moment to realize that this was Sir Joseph Hooker, the great botanist who was Darwin's friend and adviser more than fifty years ago. I had never expected to look upon his face, but there he was, ninety-two years old, yet quite able to enjoy the proceedings and converse with those who were presented to



FITZWILLIAM MUSEUM, where the Chancellor's reception was held.

him. In the few words I had with him, he recalled with pleasure his botanical trip to Colorado with Asa Gray. Old as he is, he has by no means given up botanical work; a paper describing new Asiatic species of *Impatiens* appeared only the other day.



SENATE HOUSE (to the left of picture), where the addresses were presented and the honorary degrees conferred.

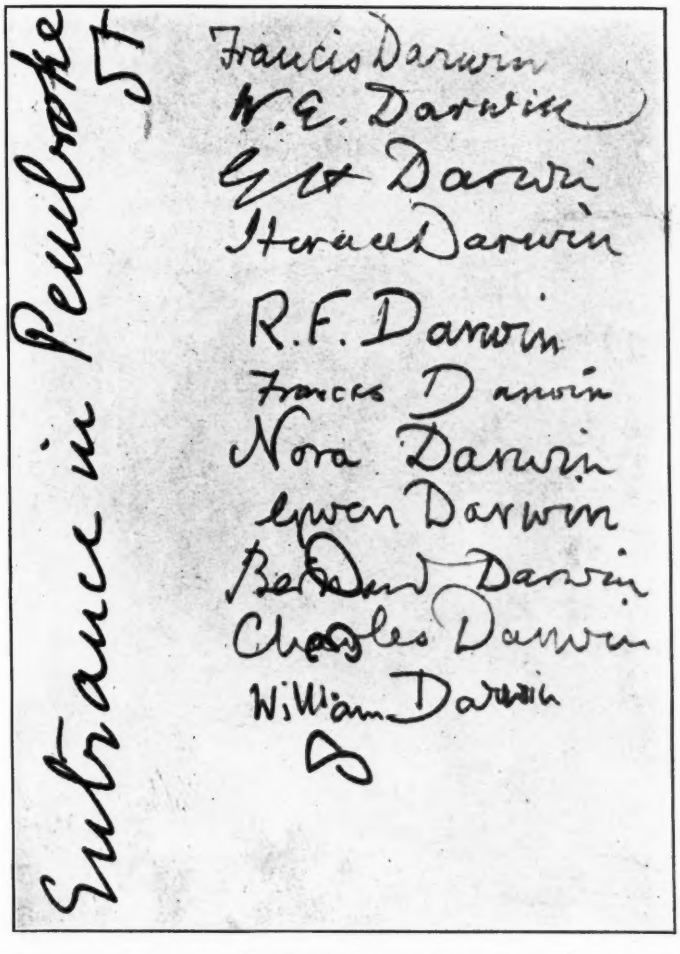
On the morning of June 23, in the Senate House, was the ceremony of presenting addresses. These were of course not read, but were handed to the chancellor as the names of the delegates were announced. Some, perhaps expecting to make a short speech, had no document to offer, but others had quite large books, elaborately bound and ornamented. The Japanese offerings looked particularly bulky and interesting; one could not help feeling curious as to their contents.

DR. FRANCIS DARWIN.

Although it was impossible to read the addresses, short speeches were made by representatives of Germany, France, the United States and Great Britain, these being Professor Oscar Hertwig, Professor Metchnikoff, Professor Osborn and Sir E. Ray Lankester respectively. The last speaker took somewhat controversial ground, maintaining the validity of the theory of the natural selection of minute and ubiquitous variations, and stating that certain views advanced by modern naturalists had been duly considered by Darwin, and for sufficient reasons set on one side. It could not be doubted, he said, that Darwin would have

been deeply interested in Mendel's results, but these, although throwing light on the mechanisms concerned in hereditary transmission, were not in any way opposed to Darwin's great theoretical structure.

In the evening of the same day there was a great banquet in the new examination hall, 538 men sitting down. A few wives and daughters, as the custom is, were permitted to observe the feast from a gallery. We were furnished with printed lists, showing where everybody sat; so it was equally easy to find one's own place, and to learn the names of all one's neighbors. The menu was printed in a little booklet, on the outside of which were portraits of Darwin at the ages of seven and fifty-nine. There were blank pages, and so the books circulated round the tables, and came back full of pencilled signatures. The tables were



Signatures of members of the Darwin family present at the garden party given by them to those in attendance at the meeting. The first four are sons of Charles Darwin. The others are grandchildren. (The other writing on the card is that of Francis Darwin.)

DARWIN COMMEMORATION

1809–1859–1909

CAMBRIDGE
UNIVERSITY

BANQUET

23 JUNE 1909

Charles Darwin

ÆT. 7 ÆT. 59

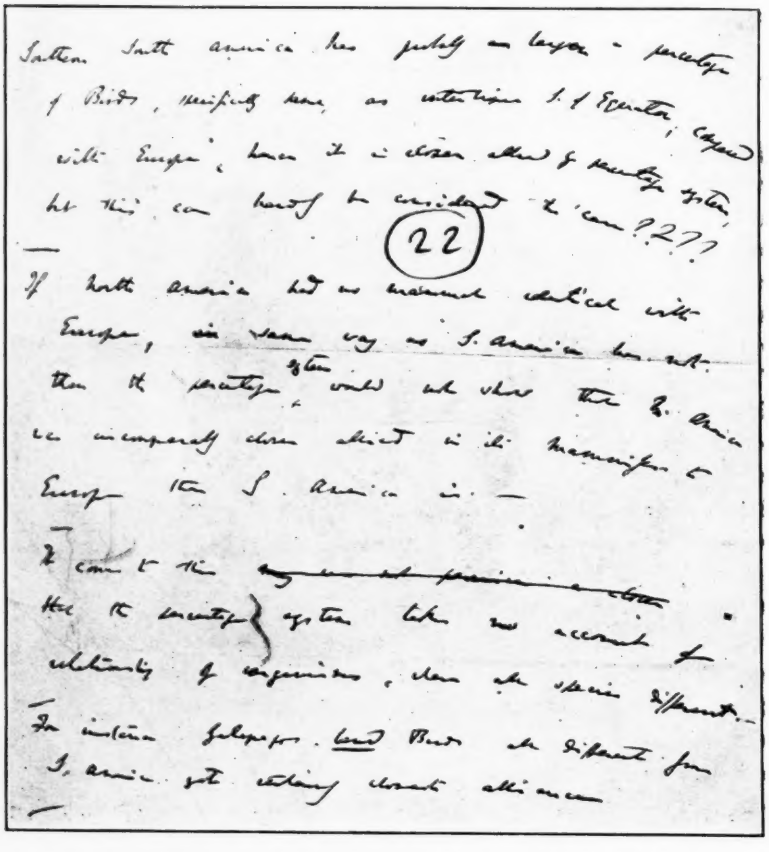
COVER OF MENU CARD AT THE BANQUET.

decorated with flowers, one of which, chosen I believe at Professor Bateson's suggestion, was the Myrtaceous *Darwinia hookeriana*. As we left the table several of us took specimens to preserve in remembrance of the occasion. The speeches at the banquet were made by the Right Hon. A. J. Balfour, Mr. William Erasmus Darwin (Charles Darwin's oldest son), Dr. Arrhenius and Professor Poulton. The most interesting was naturally that of Mr. Darwin, who gave his recollections of his father. He said that in trying to think out his father's characteristics, the one which came most prominently before his mind was his abhorrence of anything approaching oppression or cruelty, and especially of slavery. Almost the only occasion when he had known him to be angry was when a subject of this sort was brought before him. He also spoke of the way in which Darwin treated his children, playing with them when they were young, and later treating them with entire trust and freedom. "It was rather touching to remember the tone of admiration and gratitude with which he acknowledged any help which they could give him." Mr. Darwin also referred to his father's modesty, and could imagine him saying, with a note of deprecation in his voice, that if there was to be a celebration, there could be no more fitting place for it than Cambridge.

At the close of the banquet the vice-chancellor got up, and spoke of the regret which all felt at the absence of Dr. Alfred Russel Wallace. It was proposed to send a telegram to him as follows: "The naturalists assembled at Cambridge for the Darwin celebration, can not forget your share in the great work which they are commemorating, and regret your inability to be present." This was endorsed by the most tremendous and unanimous applause; the vice-chancellor, speaking for himself, said he only regretted the word naturalists, as this might seem to exclude from participation such persons as himself, who, though engaged in other than biological work, were strongly in accord with the sentiment of the telegram.

Although Dr. Wallace could not prudently have endured the stress of the celebration, in which he would have been a central figure, I may be permitted to report that his health has much improved recently, and when I visited him in August he was as active minded and ready to discuss the celebration and other matters as one could have expected had he been thirty years younger. His garden is as beautiful and full of rare and interesting plants as ever, and he is collecting materials for a new book.

On the following day, June 24, the official proceedings closed with a session in the senate house, at which honorary degrees were conferred on a number of delegates, and the Rede Lecture, dealing with Darwin's contributions to geology, was delivered by Sir Archibald Geikie. On this occasion a venerable lady was observed occupying a chair, con-



PAGE OF DARWIN'S WRITING, taken from one of his note books, believed to be prior to 1859. Given to Mr. Cockerell by Dr. Francis Darwin.

"Southern South America has probably a larger percentage of birds, specifically same, as intertropic S. of equator, compared with Europe; hence it is closer allied by percentage system, but this can hardly be considered the case ? ? ? ?

"If North America had no mammal identical with Europe, same way as S. America has not, then the percentage system would not show that N. America was incomparably closer allied in its mammifers to Europe than S. America is.

"It comes to this, that the percentage system takes no account of relationship of organisms, when all species different.

"For instance Galapagos *land* birds all different from S. American. Yet certainly closest alliance."

[This is a very good example of his manner of criticizing his own methods, or methods presented to him, and considering the matters involved from every point of view.]

trary to all custom, on the floor of the senate house. It was Mrs. Huxley; to whom else could the unique distinction have been offered?

Degrees were conferred on twenty-one delegates, nearly all of them men whose names are familiar to every biologist.

Three Americans received degrees, Wilson, Loeb and Walcott. It is not customary for the university to confer degrees upon its own mem-

bers, but an appropriate exception was made in favor of Francis Darwin, who, when he came forward, was received with deafening applause. With this exception, we thought de Vries was the most heartily received. The public orator, Dr. Sandys, made an appropriate speech to each one in Latin; here and there the resources of that language were somewhat taxed to find the means of describing the recipient's attainments. Was it justifiable, for example, to tell de Vries that he had worked on the *Primula vespertina?* We waited with curiosity to hear the Latin for Dr. Walcott's middle name, but it was discreetly skipped. The Rede Lecture was so appropriate and correct as to be somewhat dull, and had the misfortune to come when every one was tired out.

In the afternoon there was a garden party at Trinity College, given by the members of the Darwin family. Here were four sons and two daughters of Charles Darwin, seven grandchildren and one great-grandchild. The last mentioned, Ursula Darwin, aged ten months, daughter of Bernard Darwin, seemed to realize the dignity of her position. The high ability shown by Darwin's children is at least in some degree possessed by the third generation, as Charles Darwin, son of Sir George Darwin, was this year fourth wrangler.

After the Cambridge celebration was over, a large part of the Darwin exhibit was moved to the Natural History Museum at South Kensington, and to this was added a large collection of specimens of all sorts illustrating Darwin's theories and observations.

Some important literature was published at Cambridge in connection with the celebration. The most interesting was a small book entitled "The Foundations of the Origin of Species," being Darwin's original outline written in 1842, showing that his theory was far developed even at this early date. This work, edited by Francis Darwin, was issued in a special edition, a copy of which was presented to each of the delegates and guests.

"Darwin and Modern Science," edited by Professor Seward, is a large volume containing twenty-nine essays by prominent evolutionists. This will be familiar to students in America, and so need not be described. *Christ's College Magazine* issued a very interesting centenary number; while the "Order of Proceedings," given to each delegate, contains a sketch of Darwin's life, with admirable portraits of Darwin, Mrs. Darwin, Henslow and Hooker. There are also catalogues of the exhibits, both at Cambridge and South Kensington, both containing a quantity of interesting information.

DARWIN'S PROBABLE PLACE IN FUTURE BIOLOGY

By Professor WILLIAM E. RITTER
MARINE BIOLOGICAL STATION OF SAN DIEGO, CALIFORNIA

THIS centenary of Darwin's birth and semi-centenary of the publication of "The Origin of Species" will stimulate greater interest than ever in the illustrious naturalist's life and work. It may be hoped that the retrospective mood and generous spirit wont to pervade commemorative periods may contribute to better understanding and juster estimate of his achievements.

A strong current in biological thought is now running counter to belief in natural selection as an adequate explanation of evolution. One not at home in the biological literature of the day has but to read such general books as Morgan's "Evolution and Adaptation" and Kellogg's "Darwinism To-day," to feel the force of this current. That it is destined to wax stronger appears certain. Until its meaning is rightly seen it can but work injuriously to Darwin's fame.

Such productions as Dennert's "At the Deathbed of Darwinism" are symptomatic, though peevish, irreverent and false. They indicate disease somewhere in the body of evolutional doctrine. According to my diagnosis, the disease is seated near the vitals of the body and the name by which it is known is neo-Darwinism. It is a morbific growth and only its removal can restore the patient to health.

For a full generation, trade-marked expounders of evolution have insisted that only natural selection is true Darwinism. Powerful voices among these have said that natural selection is the full explanation of evolution, and on this basis are known as neo-Darwinians. By general assent natural selection becomes Darwinism, and by high authority Darwinism becomes neo-Darwinism. Consequently, now that neo-Darwinism has had time to come near its perdition, it not unnaturally seems to the little discerning to be dragging all evolution with it.

What did Darwin really do? Let us ask the question during this first centennial year of his birth, as though expecting the answer from the second centennial of his natal day.

To begin with, he gave us one of the noblest examples of a life devoted to search for truth that the modern world has seen. Splendid as are his works, more splendid still was the man. Every human life —every life—viewed from the standpoint of the larger, truer biology, must be seen to be greater than any of its works, for its works are but parts of the whole, and in biology, as elsewhere, a part is less than the

whole. Viewed from the eminence of his own example, we shall see where he fell short and was led into error with as even an eye as we shall see what he did that must endure as long as science itself shall endure.

Directing our question to the works themselves, this is the answer that comes prompt and clear: Darwin convinced everybody competent to judge the case on its merits that new kinds of plants and animals originate naturally, not miraculously. He not only convinced experts of this truth, but he gained for it a secure place in the great, irresistible tide of common thought and life. Such was his supreme achievement. Many of his ardent disciples have not been content to accept this, for them, too modest appraisement of his work. They have said his true greatness lies not in his having established the "mere fact of evolution," but that he explained that fact—that he discovered the *how* and *why* of evolution.

The verdict of inexorable time will refuse to Darwin the glory of having really explained the origin of new species of organisms. It will allow that he did much in this direction, but not greatly more than others past and future have done and will do. Fame's recompense so far as this is concerned, Darwin will have to take share and share alike with many a fellow workman.

The question we have to consider is: Was establishing the truth of evolution an achievement of such magnitude as to enroll its accomplisher among those who belong beyond peradventure to all the ages? My answer is, yes. The reason for the answer, reduced to smallest compass, is that in doing this Darwin brought into the fold of observation and rational thought the latest and greatest ingredient of reliance on the order of nature, of belief in the infinite whole of things, of faith in the dignity and destiny of man. We here approach one of those vast realms of truth and human concern, the earliest visions of which are always gained by those geniuses known to us as prophets and poets. "Faith is the substance of things not seen," said in essence the philosopher disciple.

> O Faith, that meets ten thousand cheats
> Yet drops no jot of Faith!
> Devil and brute Thou dost transmute
> To higher, lordlier show,
> Who art in sooth that lovely Truth
> The careless angels know!

So speaks England's foremost living poet.

Darwin, more perhaps than any other single man of science, contributed to the incarnation of the truth presented here as vision; and only in so far as it is incarnated does it become daily bread for common men. Through such incarnations alone are men convinced that no lawlessness exists or ever has existed anywhere in nature, that nothing

ever happens or ever has happened of such character as to wholly thwart and put to confusion the perfectly sober, the truly devout mind of man. When in the future laborious science shall have made itself and common humanity more fully and securely possessed of this truth, then will Darwin's labors stand revealed in their true grandeur.

Biologists are wont to say that evolution is now universally accepted. To see how far this is from true in a thoroughgoing sense, one has but to recall that Alfred Russel Wallace, the co-discoverer with Darwin of natural selection, denies evolution for part of man; and that an untutored, unbalanced woman, Mrs. Eddy, founds a religious cult, one cornerstone of which is an implied denial of universal evolution, which cult gets in a generation a larger following than any other started in recent times.

It is impossible to argue out the full case of the universality of organic evolution here. To do so would lead into the lowermost subtleties of technical science and logical process. A few of its surface strata must suffice for now.

Go to history to learn about the development of great ideas in physical science and you will see how, over and over again, this development has run much the same course. Three distinctly characterized stages are seen in these developments. The first is that of intuitive perception; of spontaneous, vague, fragmentary statement; of badly jumbled observation and fancy, thoughtfulness and vagary, truth and error. During this time scientific proof in the strict sense hardly appears at all.

Then comes the stage of what might be called discursive demonstration. The advance of this beyond the first is enormous in both essentials and consequences. Its greatest significance lies in the fact that the mind's ability to distinguish between *demonstrated* truth and *possible* truth has now found itself. The difference between generalizations and theories about nature that rest on objective experience, and such as may possibly be true, though they have no experiential basis, now begins to be clearly seen.

Finally comes the third stage, fundamentally differentiated from the second by the fact that the mind has at last grasped the vital meaning of quantitative values in demonstration. Evidence is now no longer *primarily* discursive and *incidentally* mathematical, but is *essentially* quantitative as well as qualitative. This quantitative stage biology is now barely on the threshold of.

It was Darwin more than any other biologist who carried the idea of evolution into the second of these three stages. Failure to grasp the full significance of this forward step must mean failure to assign to him his true place in the history of thought.

It has been pointed out time and time again that the evolutionary

interpretation of living nature did not originate with Darwin; that in fact it is as old as Greek philosophy at least. And because, so the view has run, he was not a discoverer in this but only a promoter, there was not sufficient ground upon which to build a truly immortal fame. Such fame, so it has been maintained, could be reached only through a supreme original discovery. Such a discovery was natural selection, the greatness of which consisted in its being the chief if not the sole explanation of evolution. Now, however, we are coming to see that Darwin erred, and that some of his followers have erred more, as to the power of natural selection in species transformation.[1]

[1] Since the manuscript of this essay went to the publisher, the celebrations of Darwin's birth have been held at Cambridge University. On one of the occasions Sir E. Ray Lankester is reported (*Nature*, July 1) to have said:

"I think that the one thing about Charles Darwin which the large majority of British naturalists would wish to be to-day proclaimed, in the first place—with no doubtful or qualifying phrase—is that, in their judgment, after these fifty years of examination and testing, his 'theory of the origin of species by means of natural selection or the preservation of favored races in the struggle for life' remains whole and sound and convincing in spite of every attempt to upset it."

Also in the meantime the paper by Drs. Raymond Pearl and Frank M. Surface, entitled "A Biometrical Study of Egg Production in the Domestic Fowl" (Bull. 110, part 1, Bureau of Animal Industry, U. S. Dept. of Agricul.) has reached me.

From the mathematical treatment of the data collected through eight years of rigid selective breeding aimed at the improvement of egg production in chickens, the authors say: "It is shown that during the period covered by the statistics (1899–1907), which covers practically the whole period of the breeding experiment, there has been, apart from fluctuations up and down in individual years, a small but steady decrease in the mean or average annual egg production."

"The percentage of extremely high layers (producing more than 195 eggs in the pullet year) in the flock decreased during the period from 1899 to 1907. The percentage of exceptionally poor layers (producing less than 45 eggs in the pullet year) in the flock increased during the same period."

And concluding, the authors say: "It is shown that the intensity or stringency of selection became relatively greater during the progress of the experiment, though the absolute standard of selection remained the same. It is further shown that there is no evidence that the selective breeding practiced has improved the strain in respect to egg production. On the contrary, the data show that (*a*) the mean egg production has diminished during the experiment; (*b*) the variability in egg production has remained unchanged, and (*c*) in the last years of the experiment relatively slight environmental changes caused very marked changes in the flock productiveness. This is obviously inconsistent with the view that any particular type of egg production has in any way been fixed in a strain by breeding."

Reading Lankester's statement in the light of this work at the Maine Agricultural Experiment Station, and of several other late researches of like import but less demonstrative value, I am, after the manner of Abraham Lincoln, reminded of a story: A Jersey farmer on his first visit to a menagerie came upon the dromedary. After scrutinizing for a long time in amazed silence

It will require some generations yet to find out even approximately what rôle the wonderful process of struggle and selection plays in species-making. But it is becoming clear in part wherein and why Darwin and, following him, all the rest of us, have gone so wide of the mark concerning it. The subject is too vast to touch more than summarily here.

It is the very essence of the human mind to inquire after the causes of whatever happens in this world of ours. It is the essence of science to hold that these causes are natural, not supernatural. Darwin became convinced that species arise naturally while yet the philosophy of living things in which he had been nurtured contained practically nothing concerning any natural cause that could be assigned to species production. Special or supernatural causation was held as a dogma rather in default of evidence of natural causes than from proof of supernatural ones. So religious superstition and dogmatism had a free field here. Darwin's naturalist instincts said: "Since species arise naturally, natural causes sufficient therefor must exist. If they are natural they are ascertainable. I will search for them." So he set about the task with the result that all the world knows. He discovered the process called by him natural selection, and saw it to be a real cause in the generation of species.

Now comes the greatly important point. I have said Darwin carried the evolution idea into the second of three stages through which interpretations of the world usually run; the stage, namely, of qualitative, discursive demonstration. Not having yet reached the third stage, that of quantitative demonstration, he had no way of *measuring* in a mathematical sense the efficiency of natural selection. He could establish no quantitative relation between cause and effect. In fact he did not look at the problem from the quantitative standpoint in the proper sense at all. So it was almost inevitable that he should exaggerate the power of the cause he had discovered. And see the essential nature of this exaggeration: Before Darwin supernatural causes were held to account for the origin of species. But supernatural causes are always adequate, final. Supernaturalist doctrines are always absolutist doctrines. Therefore effort to make natural selection supplant supernatural causation is effort to make it, too, adequate, final. Attempt to make natural selection the sole, the complete cause of evolution, and you become a finalist, an absolutist. In a word you retain the essence of supernaturalism. Absolutist natural selectionism is only a disguised

the misshapen legs, cloven feet, pendulous lips, and curiously mounded back of the sleepy beast, the old man turned away with the remark "there ain't no such animal!"

I may be wrong as my sources of knowledge are limited, but I believe a considerable number of British naturalists will refuse to let Sir E. Ray take them with him into the class with the Jersey farmer.

form of supernaturalism. It is failure to recognize that by its essential nature physical science can deal with causation only piecemeal; that it can only grasp causes one by one and can never get them all. Absolutism is supernaturalism, and under whatever disguise is the seemingly everlasting and implacable foe, not merely of inductive science, but of rational conduct. Would that somebody might set forth this truth in words so hot that they should burn themselves ineffacably into the philosophy, the science and the daily round of common life of our and of all future generations of men! With what serenity some of our best accredited men of science are themselves striving, and advising the neophytes in science to strive, for the solution of ultimate problems! So long as this is so there is necessity for, and will surely always be, theosophy, christian science and the whole retinue of psychic absolutisms. The one brand of finality is but the counterpoise of the other.

Though still in the second stage of idea-development as regards natural selection, a few important truths about the process are being revealed to us that Darwin overlooked, or did not sufficiently emphasize. In the first place, while he soon saw that natural selection could not be the sole cause of evolution, and while he recognized it to be a cause of a general nature, he never grasped in its full meaning the truth that there are not one, nor a few, nor even many, but literally an infinite number of causes at work in the production of species.

It is curious, once one comes to think of it, that Darwin and the rest of us should have talked so long and so absorbedly about one or a few "factors" of evolution when the demands of rigorous science are that there shall be at least as many causes as there are species. Were this not so the same cause would produce different effects, and that would make biology a hocus-pocus indeed. Supernatural causes would be quite as amenable to science as such natural ones. Trouble has befallen us here from not having listened with due attention to what David Hume has told us about causes. His definition of a cause as "*an object followed by another, where, if the first had not been, the second never had existed,*" has not sunk deeply enough into our minds.

The course by which we have seemed to keep out of this limbo has been exactly one element in our discomfiture. We have said "Why, to be sure natural selection always takes variation and heredity for granted. Darwin made that clear enough." But when we make the causes of evolution our problem, why not face the music squarely? Why not make sure of the causes first and classify and name them afterwards? That is the way we proceed in systematic botany and zoology.

The truth is, natural selection itself is a great bundle of causes some of which are different in each particular case to which the bundle applies, so must be separately investigated for each particular species.

Does any *Allmacht* natural selectionist believe in his heart of hearts

that even an approximate consensus of opinion among biologists will ever issue from such general discussion of the "natural selection factor" as has been carried on during the last half century? I do not think so. The most that can be said for such views is that they stimulate research. But there is an aphorism in hygiene about over stimulation that ought not to be forgotten even in science, when stimulants are advocated.

What more prophetic utterance of Darwin's can be found than that made to Wallace after he had thought over natural selection for twenty years? "My work," he said, "will not fix or settle anything."

Another important matter that Darwin never laid hold upon with sufficient grip is the great significance of struggle aside from its rôle in species production. The numberless things that struggle may accomplish short of killing somebody, did not greatly attract his attention. From his standpoint struggle short of life and death struggle seems not to have counted for much. So in his writings struggle almost always appears as "struggle for existence."

Nature is exactly a vast system of parts, each part having a nature of its own, but at the same time being dependent upon innumerable other parts.

"Natural selection" (the expression has for the most part been restricted to the living world, but there is no essential reason why it should be. It would be quite as explanatory of the process of origination, applied in the inorganic, as in the organic, realm) is that complex of operations by which natural bodies get so located that the capabilities of portions of nature for doing their part toward the sustentation of other portions are utilized to the best advantage. Otherwise stated, it is the method by which organisms become arranged in nature according to their special needs and merits. In this operation, inconvenience, injury and destruction often result. But such results are *among others,* rather than the end and aim, the total result of the process. In many cases, though by no means in all, it must play a large part in determining the characteristics, especially in late life, of individual organisms. In a word, natural selection is probably one *vera causa* in species formation. In what instances it has been thus influential, and how far this influence has gone, are matters to be ascertained, as far as possible, *in each particular case.* If Greenland has the wherewithal to support men, in however meager and cheerless a way, it is at least as reasonable to conceive Mother Nature (if one is to personify nature) as congratulating herself that she has some men able to accept such bounty and like it, as to conceive her as fiendishly gloating, or filled with impotent grief, as the case may be, over having crowded a few of her mortal beings off into so hard a quarter. Darwin did not view the process in this light very much.

Again, a phenomenon of organisms that Darwin appealed to in elaborating his hypothesis is their prodigality in generation. He almost always looked at this from the standpoint of the inevitable crowding and struggle, carnage, famine and death, that result.

But there is another direction from which this prodigality must be viewed, namely, from that of the absolute interdependence, the reciprocal relationships that prevail among organisms. Though always consumers, organisms are likewise always producers, and are producers in *larger measure than is necessary for their own perpetuity and best interests.* "Every species is its own worst enemy." There is consequently, on the whole, a surplusage of product as regards both the individual and the kind. So it comes about that the consumption that is going on is in part a consumption of surplus. Do not understand me to say that this is *the* correct view of the matter while the other is incorrect. Both views are true, and hence exclusive or unbalanced attention to either is inadequate.

Our conclusion amounts to this: Darwin's fame will grow in luster parsi passu with growing recognition that he did not discover *the* cause of evolution. This paradoxical statement ought to be viewed askance, as all paradoxes should be. But see its justification. We biologists will be able to approach the important truth of struggle in animate nature with minds open for evidence of every sort as to its meaning when we shall have broken up the habit—for habit it has surely become —of attributing to it powers and capabilities beyond those it actually has.

We turn again to the greater side of Darwin's work. Transform yourself in imagination to a state of mind that holds all the natural kinds of plants and animals by which you are daily surrounded, to be each an independent miraculous creation, to be objects, that is, concerning the origin of which no human being shall ever gain the slightest real knowledge. Thus transform yourself, and then, and only then, may you grasp the momentous significance of the extension of the domain of law in the physical world wrought by the establishment of the "mere fact" of evolution.

Since my position makes so much of the distinction between establishing the truth of evolution and discovering the adequate cause of evolution I must justify myself more fully. Let us ask how sharply Darwin himself made this distinction, and how he appraised his own work from this standpoint.

That Darwin was convinced of the *fact* of descent with modification before he had any working hypothesis as to its *cause,* in other words, that he was an evolutionist before he was a natural selectionist has not been given due weight, though perhaps is well enough known. Let us look briefly at the evidence for this statement.

The aid of Francis Darwin, his son is important here. The chief sources of information are the two editions of the "Journal of Researches," and his early notes and queries printed after his death. The first edition of the "Journal" was finished in 1838, though not published till the following year. It was in October, 1838, that he read Malthus's "Essay on Population," the incident that started him on the road to natural selection. The first edition of the "Journal" was, consequently, practically uninfluenced by his famous causal hypothesis.

Discussing this early period of his father's ideas, the son writes:

> After reading the second edition of the "Journal" (published in 1845) we find a strong sense of surprise at how far developed were his views in 1837.[2]

It will be observed that 1837 was the year before the Malthus essay was read. But the evidence from posthumous notes is more to the point. The son remarks:

> We are enabled to form an opinion on this point from the note-books in which he wrote down detached thoughts and queries.

From these I quote a few.

> Propagation explains why modern animals same type as extinct, which is law, almost proved.
>
> If we choose to let conjecture run wild, then animals, our fellow brethren in pain, disease, death, suffering and famine—our slaves in the most laborious works, our companions in our amusements—they partake (of) our origin in one common ancestor—we all may be melted together.
>
> It is a wonderful fact, horse, elephant, and mastodon, dying out about same time in such different quarters.
>
> They die, without they change, like golden pippins; it is a *generation of species* like generation of indivduals.
>
> . . . so with useless wings under elytra of beetles—born from beetles with wings, and modified; if simple creation merely, would have been without them.

So much for evidence that Darwin was an evolutionist before he was a natural selectionist or had any other causal hypothesis. As to the relative value set by him on his part in establishing the "mere fact" of evolution, and his effort to explanation of that fact, the son's testimony is again important. He writes:

> It comes out very clearly that . . . my father did not rejoice over the success of his special view of evolution, viz., that modification is mainly due to natural selection; on the contrary, he felt strongly that the really important point was that the doctrine of Descent should be accepted.[3]

Any one who knows Darwin's life-work in spirit as well as in letter will accept this statement unhesitatingly. Utterances of like import by Darwin himself are numerous. For brevity's sake I give but one. Writing to Asa Gray in 1863, he said:

> I have sometimes almost wished that Lyell had pronounced against me. When I say "me," I only mean *change of species by descent*. That seems to me the turning-point. Personally, of course, I care much about natural selec-

[2] "Letters," I., p. 367.

[3] "Letters," II., p. 163.

tion; but that seems to me utterly unimportant, compared to the question of Creation *or* Modification.[4]

How vitally it concerns both justice to Darwin and sound views of life generally that technical biology and lay understanding alike should face right in this matter!

But if natural selection is really unimportant as contrasted with evolution, how has it come to occupy so large a part of the stage? How is it that accredited expounders of evolution the world over have insisted that natural selection is the only genuine brand of Darwinism, and must be the corner-stone of Darwin's greatness?

The elements entering into the answer are manifold. Three have been indicated already. These may be summarized thus:

1. Undue weight has been attached to the fact that the idea of evolution did not *originate* with Darwin but is "old as thought itself." Absence of adequate experiential evidence for the truth of this vague idea until Darwin produced it, has not been given enough importance.

2. With the passage of time and our familiarization with the idea of evolution there has been a tendency to minimize the importance of the grip in which miraculous creation held men's minds up to the Darwinian era.

3. A wholly unwarranted importance has been attached to the part played by the natural selection hypothesis in *promoting belief* in the truth of evolution. Darwin became an evolutionist before he was a natural selectionist, and there is good reason for supposing the rest of us would have gone with him had he never thought of natural selection.

Other elements in the answer to our query must now be taken up. In the first place, Darwin himself placed a heavier burden of causal efficiency on his hypothesis than it is able to bear. This he at length acknowledged in his usual open, honest way. Perhaps his most positive statement to this effect is in "The Descent of Man."[5] It has often been quoted, though hardly enough heeded. He says:

> I now admit, after reading the essay by Nägeli on plants, and the remarks of various authors with respect to animals, more especially those recently made by Professor Broca, that in the earlier editions of my "Origin of Species" I probably attributed too much to the action of Natural Selection or the survival of the fittest. I have altered the fifth edition of the Origin so as to confine my remarks to adaptive changes in structure. I had not formerly sufficiently considered the existence of many structures which appear to be, as far as we can judge, neither beneficial nor injurious; and this I believe to be one of the greatest oversights as yet detected in my work.

But the mischief had been done, and Darwin's inability to remedy it troubled him not a little.

Let us see if there is anything either in his argument itself, or in his

[4] "Letters," II., p. 163.

[5] I., p. 146.

mode of handling it, that set the tide of his influence wrong beyond his power of righting.

For one thing, Darwin was unfortunate in the title chosen for his foundation book. "The Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life" is the title in full. A little reflection discovers ambiguity in this. Is the author concerned primarily with the *origin of species* or with *a particular way* of accounting for their origin? One piece of internal evidence of a general character is to the effect that the second alternative is the true one. The explanatory hypothesis is treated first and occupies fully half the work, while the observed proofs of origin by natural modification are given second place. Why did not Darwin present his proofs of evolution first and his hypothesis second, thus making his title and order of treatment correspond? The fact is he wavered as to where the emphasis should be laid touching the relative importance of the two objects he tells us he had in view in writing the "Origin." This wavering he never to the end of his life was able to fully correct.

We can point out specifically how this equivocal meaning of the title has operated to make Darwin a natural selectionist in a sense that he himself resisted. One biologist, a particularly strong pro-natural selectionist, has written:

> This title is of interest, as has been pointed out by Professor E. Ray Lankester, in relation to the controversy upon the exact meaning of the word "Darwinism." Some writers have argued that the term "Darwinism" includes the whole of the causes of evolution accepted by Darwin—the supposed inherited effects of use and disuse and the direct influence of environment, which find a subordinate place in the "Origin," as well as natural selection, *which is the real subject of the book and which is fully defined in the title.* It would seem appropriate to use the term "Darwinism" as Wallace uses it, to indicate the causes of evolution which were suggested by Darwin himself, excluding those supposed causes which had been previously brought forward by earlier writers, and especially by Lamarck.[6] (Italics mine.)

The large conception that "Darwinism" might be "evolutionism" has no place in this author's mind, so it would seem from this statement. Darwinism according to such a view must have sole reference to certain specified causes of evolution instead of evolution itself through any and all causes that may be behind it. The power of mental bias to lead men unconsciously wrong is not often more strikingly illustrated than in this; for here it goes to the extent of making professed followers and admirers of Darwin do him grave injustice. What meaning can Darwinians who thus circumscribe "Darwinism" put into such of their prophet's language as this?

> I may be permitted to say, as some excuse, that I had two distinct objects in view, firstly, to show that species had not been separately created, and secondly, that natural selection had been the chief agent of change, though

[6] Poulton, "Charles Darwin," p. 99.

largely aided by the inherited effects of habit, and slightly by the direct action of the surrounding conditions. . . . Some of those who admit the principle of evolution, but reject natural selection, seem to forget . . . that I had the above two objects in view; hence if I have erred in *giving natural selection great power, which I am far from admitting,* or in having exaggerated its power, which is in itself probable, I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.[1] (Italics mine.)

The kernel of the bias that has done so much harm is not difficult to find. Pursuit of the question as to which one of several supposed causes of evolution is the *whole cause,* has been so ardent that the extremists among the upholders of the particular cause discovered by Darwin, have been blinded to what he himself has declared to have been the first of two objects in writing the "Origin of Species."

The question of what "Darwinism proper" shall be is relatively insignificant. If one's linguistic taste favors making Darwinism apply to the particular causal principle discovered by Darwin, well and good. Then Darwinism is of no great moment, relatively. On the other hand, if one's taste is more catholic, he will prefer to have Darwinism apply to the really great thing that Darwin did, and the term will mean organic evolution, the unfailing reign of law in the origination of living beings, one of the greatest truths of nature, when its establishment shall be complete, that the mind of man has yet possessed itself of.

While Darwin himself was not without responsibility for this narrowing, withering view of what "Darwinism really is," by far the greater responsibility rests upon two other men, namely, Alfred Russel Wallace and August Weismann. These two, each truly eminent in his own right, have been looked upon by a too little-discerning biological period as those upon whom the "mantle of Darwin" has fallen. Let us away once and for all with this false and flimsy notion about any man's mantle falling upon some other man! Every man's mantle, be he great or small, is his own alone, and goes to his grave with him, or ought to be allowed to. What kind of self-esteem is that which wants the distinction of wearing another's clothes? Mr. Wallace has certain interesting biological ideas and so has Professor Weismann. The ideas of both have much in common with ideas held by Darwin. Both men have worked out their ideas as best they could, greatly influenced no doubt by the methods and writings of Darwin. But Mr. Wallace's ideas are his, Professor Weismann's are his and Mr. Darwin's were, and shall be, his. Let us take them all and estimate them on this basis. In so far as all three or any two sets are alike, let us recognize the resemblance; but in so far as they differ, let us see the differences also.

The relation of Weismann's doctrines to Darwin's I merely touch upon here. It should be recalled that Weismann is a neo-Darwinian

[1] "Descent," I., p. 147.

of the Neodarwinians so far as natural selection goes. By far the most important nexus between Darwin and Weismann, when it comes to the deeper reaches of biological theory, is through Darwin's pangenesis hypothesis and Weismann's germ-plasm-determinant doctrine. This I treat at length elsewhere. It may be left to one side here because of its relative unimportance as touching Darwin's work proper, though of fundamental importance to an exhaustive discussion of the present status of biological philosophy.

Mr. Wallace's ungrudging recognition of Darwin's towering genius as compared with his own is one of the particularly bright and inspiriting examples of what personal relationship between men may be. And to Mr. Wallace is the greater honor because his was the lesser intellectual endowment and achievement.

Turning from Mr. Wallace's beautifully deferential attitude toward his friend, to the facts upon which he based this, what do we find?

We have already seen that Darwin had convinced himself of the truth of descent with modification before he thought of natural selection, and that it was the essay of Malthus on population that gave him the idea of struggle and survival. On December 22, 1857, he said in a letter to Mr. Wallace:

> My work at which I have now been at work more or less for twenty years, *will not fix or settle anything;* but I hope it will aid by giving a large collection of facts, with one definite end.[8] (Italics mine.)

It should be remembered that Malthus's essay was read in 1837.

The circumstances under which Mr. Wallace became the co-propounder of evolution and co-discoverer of natural selection are told by himself. He says:

> After writing the preceding paper (On the Law which has Regulated the Introduction of New Species) the question of *how* changes in species could have been brought about was rarely out of my mind, but no satisfactory conclusion was reached till February, 1858. At that time I was suffering from a rather severe attack of intermittent fever at Ternate in the Moluccas, and one day, while lying on my bed during the cold fit, wrapped in blankets, though the thermometer was 88° Fahrenheit, the problem again presented itself to me, and something led me to think of the "positive checks" described by Malthus in his "Essay on Population," a work I had read several years before, and which had made a deep and permanent impression on my mind. These checks—war, disease, famine and the like—must, it occurred to me, act on animals as well as man. Then I thought of the enormously rapid multiplication of animals, causing these checks to be much more effective in them than in the case of man; and while pondering vaguely upon this fact there suddenly flashed upon me the *idea* of the survival of the fittest—that the individuals removed by these checks must be on the whole inferior to those that survived. In the two hours that elapsed before my ague fit was over, I had thought out almost the whole of the theory, and the same evening I sketched the draft of my paper, and in the two succeeding evenings wrote it out in full, and sent it by the next post to Mr. Darwin.

[8] "Letters," I., p. 467.

Then Mr. Wallace goes on to speak of the letter from Mr. Darwin containing the quotation given above, and says:

> The words I have italicised (the same italicized in my quotation) and the whole tone of his letters, led me to conclude that he had arrived at no definite view as to the origin of species, and I fully anticipated that my theory would be new to him, because it seemed to me to settle a great deal.[9]

There you have the difference between the two men's minds, at least in their attitude toward survival of the fittest, put in a nut-shell by Wallace himself. What seemed to him from two days' reflection able "to settle a great deal," seemed to Darwin after twenty years' reflection, not able to "fix or settle anything."

Another highly instructive exemplification of this difference is furnished by a discussion between the two on natural selection and sterility. This is given us in "More Letters of Charles Darwin," letters 209–216, the correspondence having been carried on in 1868. Wallace presents (letter 211) "what appears to me a demonstration on your own principles, that natural selection could produce sterility of hybrids." Darwin's general position on the point is well indicated in letter 213. He says:

> I have been considering the terrible problem. Let me first say that no man could have more earnestly wished for the success of Natural Selection in regard to sterility than I did, and when I considered a general statement (as in your last note) I always felt sure it could be worked out, but always failed in detail. The cause being, as I believe, that Natural Selection can not effect what is not good for the individual, including in this term a social community.

Although Darwin was sure there was something wrong in Wallace's argument, and was not budged an inch by it, he seems not to have recognized its logical preposterousness. He did not explicitly point out to Mr. Wallace that since over-productivity, or geometrical increase, is one of the fundamental presuppositions of natural selection, to suppose natural selection could produce sterility would make it capable of negativing one of its own presuppositions. Stating the matter figuratively, Darwin saw no logical difficulty in the supposition that natural selection might commit suicide. With him it was merely a question of whether it does this or not, and he could not make out from the evidence that it does. But he did not see that Wallace's argument carried out consistently would not only enable natural selection to commit suicide, but in reality would make it able to prevent itself from coming into existence.

The scope and balance of Darwin's mind are seen nowhere to better advantage than in his efforts to prevent his own causal hypothesis from going beyond bounds. Nevertheless the true inwardness of the difference between himself and those who later were to produce the so-called neo-Darwinian school, the school founded on the omnipotence of

[9] Poulton, "Darwinism," p. 88.

natural selection, is nowhere better seen than in his position relative to the application of natural selection to man. While one of Darwin's greatest achievements was his proximate demonstration that man is not a being wholly cut off by his origin from the rest of nature, and while he saw prophetically rather than rigorously, that the final test and goal of all science, evolutional biology with the rest, must be its ability to help man to understand and guide himself in the full scope of his nature, he did not see, at any rate clearly, what must be the inevitable outcome of trying to make struggle and selection explain fully the evolutionary process.

He failed to see the deeper meaning of the circumstance that it must work toward making the brightness and beauty of the living world appear as though seen through a somber-colored distorting-surfaced, glass screen.

He did not see that it must foster a sort of egoism that would make the golden rule as dead on the statute books of human relationship as a mastodon in a Siberian ice-bed.[10]

The golden rule in its ethical significance does not now concern me. It is as a biological phenomenon that I am looking at it. *Living* organisms, and each one in its *totality* or so much of its totality as I can reach, are my biological data. Should I study the honey bee or the American beaver I should be adjudged an unsound biologist were I to draw sweeping conclusions about them, in which little or no cognizance should be taken of some of their most prominent traits, as for instance, of their community habits. Or still more should I be adjudged unsound were I to enter upon the study with already-fixed conceptions about instincts, let us say, that would lead me to overlook, or have to explain away, certain prominent traits.

The golden-rule trait is one that man actually presents no less surely than is the iron-rule trait. There it is, written into his history and stamped upon his behavior almost everywhere.

It is exactly the office of biology as it undertakes the study of man to frame its explanatory theories large enough to take in whatever it finds characteristic of him. If man really is a part of nature, as an unflinching evolution seems to say he is; and if natural causation really can be relied upon throughout the world, then there must be something wrong with a causal theory of evolution that not only makes no provision for, but actually negates, some of the most fundamental qualities that man's nature presents. Let us not fail to see that Huxley's trouble over the conflict between the cosmic and ethical processes involves not merely natural selection, but goes to the vitals of evolution and natural law itself. This is a mighty question.

He did not perceive that it would enable pride, avarice, cruelty and injustice to draw the sacred mantle of science about them.

Read the encyclopædias of biography from A to Z and you will find portrayed there no warmer hearted, more genuine, generous souled, open minded man than was Charles Darwin. But when you read his life for aid in understanding his work, do not fail to read the whole of

[10] My point here could hardly be misunderstood were it possible to read these statements properly set in the general discussion to which they belong.

it. He was a nature-loving, country-dwelling English gentleman of the best type—not a gentleman in the political and social sense, but in the manly sense. Further, he was to the very marrow of his bones an English naturalist as well as an English gentleman. He inherited the instincts of the naturalist and likewise the worldly wherewithal that enabled him to follow his bent without let or hindrance. So it was that the naturalist's standpoint was literally both first and second nature to him. Rarely is it the fortune of a scientific career to run through from beginning to end so strictly along the lines of instinctive choice and least resistance, as Darwin's ran. It is not too much to say that Darwin knew nothing of that sort of discipline that comes from compelling one's self to do things which initially he does not like. It is well known that even in biology, the realm of science to which by nature he so clearly belonged, he as a youth dodged those of its disciplines that he did not like, however basal they might be. For example, when trying himself out as a medical student, he did not like anatomy, so anatomy he did not study in any serious way.

Comprehensive and well balanced as became his scientific efforts and knowledge, these were always so within the bounds of predilection rather than of logical and philosophical compulsion. This I believe to be the weightiest of several reasons why Darwin saw so imperfectly the direction in which the struggle-selection principle must lead those who misunderstand and exaggerate it.

Had he grounded himself in mathematics, psychology and ethics, not necessarily as fully but as sympathetically as he did in natural history, he might have anticipated, at least in outline, what has actually happened. He might have foreseen the fate of his friend Huxley, who found himself driven to attempt the rehabilitation under an altered nomenclature of the old, old conception of the world as a battle ground, with man the chief prize, where an infinite, beneficent God is field-marshal on one side, and an infinite, malevolent devil leads the hosts on the other; and of his friend Wallace who landed finally in the shadow-realms of disembodied spirits and ghosts; and of such strong-timbered, though loosely-framed minds as that of Friedrich Nietzsche,[11] for whom

[11] This does not necessarily mean that I take sides in the controversy as to the extent of Darwin's direct influence on Nietzsche. From my standpoint it matters little, if it be true, that Nietzsche never understood natural selection. The case has to be viewed in a much broader way. Nietzsche's ethics is one precipitate, so to speak, out of the same solution that Darwin's famous hypothesis came from. This solution filled the atmosphere of the whole western world for at least a half century before these two precipitates were thrown down. The essence of this solution was not so much an exaggerated individualism as it was an individualism *waging its warfare within itself, i. e.*, with no supreme outside judge and power to guide and check, to approve fair fighting and punish unfair, and to direct the whole to some glorious end. Whatever Nietzsche's

the way of a self-annihilating individualism and utilitarianism, could hardly be other than the way to the mad-house; and finally of numberless mediumly endowed souls in whom such doctrines could not fail to beget a pusillanimous indifferentism toward all human weal excepting such as can be seen to be directly advantageous to one's own weal.

We may be sure that the volumes of social and ethical doctrine that have been written from, not the Darwinian, but the neo-Darwinian, standpoint, and the still larger volumes of unethical practise that have consciously and unconsciously been instigated and justified from the same standpoint, would have brought inexpressible anguish to the noble spirit of Charles Darwin, could he but have seen them in full flower and fruit.

My conclusion then as to Darwin's probable place in future biology may be summed up thus: Darwin has been frequently called the Newton of Biology. Not so! Newton discovered a great mathematical, that is, exactly expressible law of nature. Darwin found no such law. For its real Newton, biology will probably have to wait another fifty years at least. When he appears he will be a mathematical biologist.

If the counterpart of Darwin in inorganic science is to be sought, Copernicus rather than Newton would be the man. The revolution in men's attitude toward nature wrought by each of these was much the same, both in kind and magnitude, and both men's names will grow brighter on the pages of history so long as mortals are stirred by the beauty of orderliness and law, and by what is lovely in form and color and motion; so long as they have feelings of gratitude and obligation for what has gone to the making of themselves and the things they enjoy, what they are; and so long as their faith in the Infinite Whole of Things abides and waxes stronger.

"Super-man" may be, this much is certain: It, or hé, is man-, not God-conceived, and is to be man-, not God-created.

Nietzsche's enterprise made it necessary for him to kill God thoroughly. While even the suggestion of such a thing was abhorrent to Darwin, it is nevertheless true that among the most trusted weapons used by Nietzsche in his killing, were the very ones of individualism and conflict used by Darwin, and it matters not so far as my main point is concerned, whether Nietzsche got his instruments from Darwin or from the same factory that Darwin's came from.

THE EVOLUTION OF MAN AND ITS CONTROL[1]

By ROSWELL H. JOHNSON

An Introduction to Eugenics

THERE are two very different ways in which the progress of man may take place, and great error and confusion have arisen from the failure to discriminate them. The one consists of a change in the intrinsic qualities of men as they are born from generation to generation. This is biological progress or evolution. The other process, to some extent independent of the individual, is a change in the things men have, know, and do, and may be called social progress. If, we compare the best tribal stocks of the present with those of two thousand years ago, we find but little innate gain, but the social progress in that time has been astounding.

The comparative slowness of biological progress as contrasted with that of civilization is to be expected when we consider the power of the latter to accumulate and hand down the results of every advance, while in biological evolution there is a constant intervention of heredity on the conservative side. Although the greatest human progress thus far has consequently been wrought in the social rather than the biological field, there have always, since as early as Plato, been patriots and philosophers who aimed to uplift not only the environment of the race, but its inborn character as well. The question is—is it possible to secure for the new-born babies of the future an innate moral, mental and physical nature superior to that of the present generation?

It is as an answer to this question that the new science of eugenics is being mapped out, its field being the study of the biological factors affecting human evolution, with their application to the breeding of a better race of men. Though it deals chiefly with the laws of heredity it must consider also problems of environment and nurture, as will be seen later on.

The chief reason for the impracticability of most plans of race improvement until recent times has been that their advocates failed to regard the complex relations which social and biological progress must always bear to one another. Plato, for example, in his anxiety to allow none but superior children to be born into his Republic, was willing to give up such a valuable institution for social progress as the family. We must aim, therefore, to bring into harmony, as far as possible, the

[1] The author is indebted to Miss Jessie Wallace Hughan for assistance in preparing this manuscript for the press.

two great modes of progress, choosing such methods of biological improvement as may help rather than hinder civilization, and, where this can not be done, judging carefully in any specific case between social and biological values.

That the modern preachers of eugenics are quick to recognize their unity of interest with the workers for social and institutional progress is shown by Dr. Francis Galton:

> **Eugenic belief extends the function of philanthropy to future generations. It renders its actions more prevailing than hitherto by dealing with families and societies in their entirety, and it enforces the importance of the marriage covenant by directing serious attention to the probable quality of future offspring. It strongly forbids all forms of sentimental charity that are harmful to the race, while it greatly seeks opportunity for acts of personal kindness as some equivalent to the loss of what it forbids. It brings the tie of kinship into prominence and strongly encourages love in family and race. In brief, eugenics is a virile creed, full of hope, and appealing to many of the noblest feelings of our nature.**

CHAPTER I. *The Method of Evolution*

Before coming to a decision upon radical schemes for race improvement, it is of vital necessity that we consider first the factors of human evolution, and second the possibility and means of their control, with the relations of these means to progress that is social rather than biological. We must ascertain from biology those factors which are actively producing change in other organisms, and then determine to what extent they are potent in human beings as well.

Natural selection, though a dominating factor, is not the sole one in evolution, *determinate variation* and the *direct influence of environment* being also of great importance. Of these two the former is noncontrollable, and affects eugenics only in so far as its presence may make our work easier or more difficult; so we may confine our interest at present to natural selection and the direct influence of environment.

The latter factor brings us at once to the time-honored controversy over the "inheritance of acquired characteristics." The dispute seems to have ended in a drawn battle, one party having established its claim that modifications of the body are not inherited in kind, while the other has proved that the environment is able to originate certain inheritable characteristics, provided only the action in question is able to penetrate to the germ cells themselves. This modification of the germ cells caused by environment is called *blastophthory* by Forel, and is thus described (p. 35, "The Sexual Question"):

> **I mean by blastophthory or deterioration of the germ that which can also be called false heredity, that is, the consequence of every direct pathogenic or disturbing action, in particular, of certain intoxicants, upon the germ-cells, of which the hereditary determinants are also changed.**

An illustration of this direct influence is afforded by the experiments of Professor Wm. Tower, at the University of Chicago. It was found

that potato beetles subjected to hot, dry conditions were made lighter in color and that part of their progeny raised under normal environment retained this characteristic.

Mere modifications of muscle or brain, accordingly, as in the trained mind of a savant or the brawny arms of a blacksmith, are not inheritable, but such is not necessarily the case with a quality like smallness of stature due to under-feeding, an influence affecting the mechanism of inheritance itself.

By far the best known of the factors working upon the lower animals is natural selection; that evolution which takes place when, without conscious selective action, one generation has been contributed by a part of the previous one differing from the non-contributing portion, as when wild deer of one generation are descended only from those previously existing deer who have been able to live to maturity because of their superior swiftness. Variations are thus seized upon by natural selection and perpetuated by heredity. The evidence of such a selection in the case of man has been tangibly presented by Sir Francis Galton, Karl Pearson and others working with them.

Natural selection stands opposed to artificial selection, that which is accomplished by conscious effort, such as Burbank's famous work in the production of improved varieties of fruit. It consists of two main processes, each containing several subdivisions, and a common error has been to confine the term *natural selection* to the first of these main processes, which may be called lethal selection. The case of the deer mentioned above is an instance of lethal selection—that which results from the *death* of some individuals before reproduction is completed.

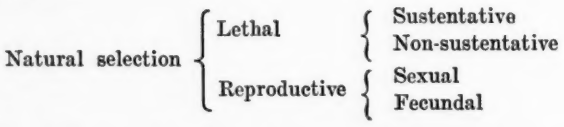
The second process of natural selection, of perhaps even more importance at present in man, is *reproductive selection,* the result, not of premature death, but of a differential number of progeny. This may sometimes counterbalance lethal selection, as in the survival of some of the lower species of animals, whose marvelous reproductive ability preserves them in the face of a very high death rate.

When the cause of the absence of progeny is a failure in the individual to mate at the proper time, it is called *sexual selection,* but if, for other causes than success in mating, the number of offspring varies among individuals, *fecundal selection* results.

Sustentative selection, the type of natural selection most commonly recognized, comes from a pressure upon the means of subsistence by proportionately excessive numbers, such as that which sent the successive waves of Aryan migration over Europe. A *non-sustentative* form of natural selection takes place from the destruction of the individual by some adverse feature of the environment, such as excessive cold, bacteria or some bodily deficiency, and is independent of mere food-supply. As Plymouth Harbor, for example, kept growing gradually

muddier, the broad crabs were subjected to a heavier death rate, so that the general type of crab in the harbor became comparatively narrow. Selection of this sort may depend on some physical advantage, or sometimes on differences in mentality, as in the survival of races of mankind intelligent enough to overcome a hostile environment—to escape cold by the use of fire or smallpox by the invention of vaccination.

The classification of the modes of natural selection is shown by the following diagram:



An indirect form of sustentative selection may be said to exist when malnutrition has the effect of destroying resistance to an adverse environment, as in the case of tuberculosis. Both modes of lethal selection, moreover, may act upon groups, as well as upon single individuals. Though group selection is best typified by a war between two tribes, such cases as the decline of the Alaskan aborigines illustrate its occurrence without combat.

Chapter II. *Artificial Selection*

Throughout the measureless ages before man natural selection worked without let or hindrance.

At last, however, the life of the tree-dwellers evolved that ape-like ancestor of ours, the tailless arboreal mammal with four hands. The hand, originally an adaptation for the purpose of grasping limbs, gradually became fitted for grasping other things than limbs, that is, for "handling" tools. Naturally such an organ made slight variations of brain structure of great advantage, for a better way of handling objects in hunting and fighting might lead to survival, not only of the individual, but also of the tribe. The resulting complexity of brain development brought with it the capacity to think, to hand on thoughts from generation to generation by oral and written tradition, and thus to formulate ideas into science.

Here, however, came a marvelous change in the methods of evolution. Although our primitive ancestors had been, up to this time, like the lower animals, a mere bagatelle under the influences of environment and heredity, thinking man now acquired the power of reflection, and even of discovering and criticizing the laws of evolution themselves. In certain cases we are able to register our dissatisfaction with the course which nature is leading us, and to make definite attempts at turning this course from the merely fittest to our notions of the best. We have learned that the forces at work changing our species are themselves partially under our control, and that, if, like the powers of the

physical world, they may at last be harnessed to the service of reasonable man, the future is largely in our hands.

Man early utilized the forces of heredity in the culture of plants and animals, and his achievements in this direction, from the prehistoric domestication of animals to the great successes of our modern breeders, have been amazing. It is natural, therefore, that philosophers should have begun their eugenic activity by recommending the direct control of heredity by thoroughgoing artificial selection, and from Plato onward we have had various projects for the deliberate improving of the human stock. Such modifications admit of accomplishment in two ways, by the prevention of breeding from the worst and by very extensive breeding from the best.

Little can be hoped from this latter method in connection with making superior women the ancestresses of the race, for at best a mother can bear and do justice to but few children. Accordingly, some polygynous device must needs be resorted to in order to utilize fully the men of best type as fathers. Such suggestions vary from free love or crude polygamy, involving as it does greater parenthood for the economically successful, to Noyes's "stirpiculture," as practised in the Oneida community, whereby a few picked men were the authorized fathers of all the children, or to G. Bernard Shaw's licensing of supermen for extra-matrimonial relations. The directness and sensational character of these projects has given them, to be sure, great notoriety, and it is perhaps to be regretted that the Oneida experiment, at least, was not allowed to work itself out as an attempt at artificial selection for the light it would have thrown on the subject.

Here, however, we must bear in mind that we are seeking social, as well as biological progress. No wholesale plan can ever prevail which denies to the majority the right of parenthood, and the family, notwithstanding the aspersions of Mr. Shaw and others, has proved too valuable a social institution to be lightly discarded. Moreover, from the viewpoint of heredity alone, any of these schemes might tend to perpetuate instincts generally considered undesirable, by breeding most extensively from those who voluntarily embraced polygynous relations.

We must have far more light from investigation and experiment before such plans as the foregoing can be profitably adjudged, and, as they are obviously out of immediate consideration, their discussion does little more than arouse prejudice and postpone real progress.

We reach solid ground for the first time when we consider the prevention of breeding from the very worst. A definite beginning of such prevention has already been made in our prisons and institutions of public charity, and the only difference of opinion can be as to just what class of inferior men and women should be cut off altogether from parenthood, and as to what methods can be employed that will not endanger social progress.

Although the limits of this class must always vary with the advance of criminology and pathology, we can almost all agree as to the inclusion of certain individuals. Among the mentally unfit for parentage may be counted the insane, the feeble-minded, and the epileptic, leaving to the future the question of "backward" children. While the criminal classes mark roughly the boundaries of the morally unfit, political offenders must of course be excluded from the category, and we must not forget that many of our criminals are made, not born, and may represent valuable variations from type. Our laws in general would better follow the tendency seen in Ferri's positive school of criminology, and determine the treatment from the nature of the criminal rather than of the crime. Those malefactors who show no improvement under reformatory influences or the indeterminate sentence may surely be included, as also all those whose record displays an excessively anti-social nature, from the murderer to the habitual drunkard.

Any attempt to weed out the physically unfit must proceed still more carefully, for we are not yet competent to point out just who come under this classification. We may be tolerably sure as to those affiicted with syphilis and with congenital defects of the senses, among the latter being reckoned many cases of deafness. Schuster's[2] investigations give the high rate of .54 for parental and .73 for fraternal inheritance in deafmutism, and other statistics give the percentage of deaf among the children of deaf parents as eight per cent. as compared with one tenth per cent. in the population as a whole. As to all others action should be very conservative, since natural selection may be trusted to take care of mere weakness and susceptibility to special bacterial diseases. In any case, it is a long and tedious process to weed out a disease susceptibility from man. A certain consumptive stock, for example, may happen to be of high social value, and there is better prospect of conquering tuberculosis by medical means than by the severe processes of artificial selection.

The prohibition of marriage within certain degrees of consanguinity would doubtless assist these preventive measures materially and here a beginning was made many ages ago. As far back as the Mosaic law, we see certain degrees of consanguinity proscribed under severe penalties, and this eugenic regulation forms a part of every civilized code.

As the list of unfit must vary considerably with scientific advance, it is best for the present to agree on the obvious defectives just mentioned, to study human heredity with redoubled vigor, and to consider carefully the means by which this prevention of parenthood may be brought about.

[2] K. Pearson, "Scope and Importance to the State of the Science of National Eugenics," p. 28.

The choice of methods must be governed by considerations of social welfare and individual happiness, and means must always vary with persons and circumstances.

The most radical remedy of all is proposed by McKim in his scheme of a lethal chamber. Since our one relic of the death penalty, however, in the case of murderers, is falling into disuse on excellent grounds, it is undesirable to suggest any such violent method of assisting evolution. Public opinion would be equally opposed to Plato's scheme of surreptitiously disposing of babies that failed to come up to specifications. Respect for human life as such has been established by society at too much sacrifice to admit of its being recklessly imperilled.

Castration is too severe a penalty for general application, though perhaps advisable in cases of rape, but Rentoul's operation, a simple process by which sexuality is retained but sterility produced, has much in its favor. In Indiana such a method has been enacted, but in general it could not fail to meet with great opposition among voters and legislators.

The most practical method under present conditions seems to be compulsory segregation, already followed in prisons and reformatories and needing only to be extended and modified. Since the confinement of the proscribed classes ought to be made terminable only by old age or voluntary sterilization, humanity dictates that in many cases celibate isolation be substituted for imprisonment. It is advisable that islands be used for one-sex colonies, thus interfering less with the happiness and health of the defective persons, allowing some degree of self-support, and making it possible for ability in special directions to manifest itself. The great advantage of this method is that, while combining effective eugenics with far greater humanity than the present prison system, it would remove the more powerful influences for evil permanently from the environment of the next generation, thus accelerating social progress to a marvelous extent.

In the case of certain congenital defectives such as the deaf, it might be sufficient to prohibit marriage with blood-relations or with other similarly afflicted persons. Some of the congenitally blind, deaf and epileptic might even be allowed their liberty under parole to refrain from reproduction or under a suspended sentence of celibate isolation.

CHAPTER III. *The Direct Action of the Environment*

Our review of the projects of artificial selection has shown that deliberate breeding from the best is for the present impossible, as well as opposed to ethical and social progress, but that the prevention of breeding from the worst is both practicable and in accordance with the best present interest of society.

The direct action of the environment has been mentioned as, aside

from natural selection and the non-controllable determinate variation, the most important factor in evolution. Since characteristics resulting from outside forces can be inherited in cases where the germ plasm itself is affected, it follows that much can be accomplished eugenically by public action with a view to environmental improvement. It is quite probable, for example, that exposure to cold, underfeeding and impure air may cause inheritable defects, judging from the before-mentioned experiments of Professor Tower on potato-beetles and the observations of Bezzola.

The seriousness of the environmental influence, furthermore, arises largely from the fact that it is not confined to one generation, but may, after once becoming established in the germ plasm of an individual, be transmitted to many generations by the ordinary processes of heredity.

As it is precisely upon combating such evils as these causes of germ deterioration that the *social* reformers place their emphasis, we have here an opportunity for the eugenicist to lend his support to those who would improve the race by modifying its environment for the better. While we can not trace accurately the germinal effects of the windowless tenement, the unventilated street-car and the factory where women work all day in poisonous fumes, yet the indications are sufficient to range the eugenicist on the side of those who demand pure air by building and factory laws.

Excessive fatigue as a probable cause of defective offspring brings us again into the domain of labor legislation, for children stunting themselves in factories and railroad men compelled to run their trains for an excessive number of hours are merely glaring instances of what may prove a most spendthrift drain upon the future in the interest of our breathless industrialism.

Since scurvy and rickets by improper food, and gout, rheumatism and Bright's disease brought on by unbalanced indulgence, might both pass on a taint to the offspring, education in hygiene assumes special importance. Our recent pure food legislation, furthermore, is an indication of what enlightened public opinion can do to protect the careless and the ignorant against the evils of malnutrition and improper feeding.

There is definite work for special legislation against certain diseases, such as syphilis, the toxin of which is known to affect the offspring, and the same may be said with regard to the excessive use of opium, cocaine and especially alcohol.

Forel gives startling facts as to the action of alcoholic poison (p. 294, *op. cit.*):

> But what is more important is the fact that acute or chronic alcoholic intoxication causes a high degree of deterioration in the germ plasm of the parents. The recent researches of Bezzola seem, moreover, to prove that the old belief in the poor quality of infants conceived during drunkenness is not without foundation. From the Swiss census of 1900, in which figure 9,000

idiots, and after a careful examination of the bulletins concerning them, this author has proved that there exist two annual maximum points for the conception of idiots (calculated by going back nine months before the day of birth). These are the seasons of the carnival and the vintage, in which there is the most drinking. Now, in the wine-growing cantons, the maximum formed by the season of the vintage is enormous and stands almost alone, while it scarcely appears in the others. Furthermore, these two maxima fall precisely at the annual period when the curve of conception for the rest of the population is at its minimum. The maximum of normal conceptions is in the beginning of the summer.

The bearing of these facts upon the regulation of intoxicating liquors need not be pointed out.

Though spread of knowledge and ethical training must be the ultimate reliance in dealing with these deleterious influences in the environment, yet they work but slowly, and legislative methods must be resorted to where feasible. In the whole great field of environmental betterment, eugenics is at one with social reform. The time has gone by when the cry of "paternalism" could block the path of protective legislation, for, even though the individualist may still claim the right to destroy himself, society must restrain him from dragging with him unborn generations to suffering and degeneracy.

CHAPTER IV. *The Action of Lethal Selection*

As natural selection is most often represented as a struggle for existence, or war between individuals or races, lethal selection of the direct group variety, by which a weaker tribe is exterminated or subjugated by a stronger, has been made much of by historians.

War, however, is losing its place as a factor in group selection, as has been graphically shown by David Starr Jordan, in "The Human Harvest." In former days, every able-bodied man was a soldier, victory depended upon personal prowess and generalship, and thus the tribe of inferior warriors was not unfrequently exterminated. At present the army is not the whole tribe, but merely a professional class, so that its personal might is no necessary criterion of the fitness of the nation. A modern victory depends on such a complex of circumstances, commerce, finances, organization and alliances, that any fitness indicated by military survival, while perhaps a very important attribute of the social organism as such, has no direct relation to the inheritable qualities of the race. Even when defeated, moreover, a modern tribe stands little chance of extermination, and may even lose fewer men than its conqueror.

When we consider selection within the race, on the other hand, war becomes a definite influence toward degeneration. The modern military system involves a selection among the adult males as to who shall be the soldiers and thus be subjected to a high death rate from disease as well as battle. Those selected as marks for bullets and fever are always, to

some extent, superior, being compelled, even in our army, to reach a good standard of physique, and in the case of officers of mentality as well. In vital struggles such as our own civil war, that appeal rightly or wrongly to principle or idealistic feeling, the ethical selection within the group, is appalling. The stagnation from which the southern states are now only just awakening after so many years is but the natural consequence of the wholesale destruction of superior men in the last generation, and much of the governmental progress of the Australasian colonies is probably due to their freedom from war under British allegiance.

Since war now means, therefore, the destruction of the young, the strong and often the mentally superior, and the survival for reproduction of those whom war can not use, it has clearly lost whatever eugenic value it once possessed, becoming on the contrary a dangerous agent of deterioration. Since to this biological cost must be added also the terrible social waste that war entails, the setting back of the hands of progress in ethics, economics and social organization, the present movement toward universal peace by arbitration must be counted as a factor tending to accelerate, rather than retard, the course of human evolution.

The old necessity for physical conflict will doubtless soon disappear as a declining birth rate removes the old cause for the seizing of territory. Indirect selection, moreover, is taking the place of war in eliminating many of the inferior peoples through an unequal struggle with disease, unfriendly nature or the complexities of civilization. Resulting largely from the superior hygienic and medical status of an economically successful people, it is now a factor of preeminent importance in the replacement of inferior races, as in North America and Australia. As advancing ethics does away with the military factor, it would be well for us to take full advantage of this indirect mode of selection, by the discouragement of miscegenation between markedly unequal races such as our whites and the negroes; it may even be desirable to prohibit, as far as possible, such marriage and cohabitation. It appears that the Aryan blood of India has been preserved effectually by the caste system, though here the racial advantage may have been outweighed by the social cost of such interference with the individual.

Immigration offers a wide and legitimate field for the application of eugenic principles. As every one knows, the old migration to our shores of such kindred stocks as the Irish, Germans and Scandinavians has gradually given way to an influx of inferior peoples from southern and central Europe, and more recently to the great stream of Asiatic and eastern European folk that are now beating, some of them ineffectually, at our doors. Shall we continue and extend the policy already inaugurated of excluding undesirable stocks? Shall illiteracy be made the test of suitability, or some deeper qualification? Or, on

the contrary, shall we hospitably ignore all race distinctions in the interest of the American employer and impose upon our public school system the superhuman task of assimilating to our own standard this polyglot avalanche? An artificial element has here been introduced into group selection, which, as wholly under man's control, deserves careful study.

Sustentative selection, in the sense in which it depends upon a supply of food and shelter insufficient for the population, has been considerably overvalued as an evolutionary factor. Very few species are affected directly by it, as is shown by the rarity of starvation among the lower animals, and in man it has practically disappeared, unless it be in India, Siam or a few savage and barbarous tribes. The advance in the sciences and arts which has so wonderfully extended our supply of wealth has abolished any necessity for sustentative selection in the civilized world, except through the artificial scarcity often maintained by the ability of some individuals to divert to their own use, or even disuse, the possible subsistence of a multitude.

Even under these conditions, our growing sense of sympathy has tempered the severity of the struggle, and among the western nations men do not starve with the conscious consent of the community. Nevertheless, in spite of charity and the poorhouse, an indirect sustentative selection is shown clearly enough by the statistical correlation between poverty and the death rate, resulting probably from improper clothing and care, or in the case of infants, from a sort of semi-starvation due to lack of suitable food. Mortality among the poorer school-children results quite as often from lack of rubbers or medical attendance as from literal under-feeding, and the deaths from tuberculosis and drunkenness, so often the result of poverty, are not put down under the head of starvation.

Spencer, among others, has urged that charity be abandoned, in order that sustentative selection be again allowed full scope, but, aside from the terrible expense in human suffering that this method would entail, we can not afford thus to imperil *social* progress by allowing poverty to work its havoc unchecked. The moral and physical diseases originating in the submerged classes do not stop at the boundaries of the slums, and may corrupt both the fit and the unfit in their progress.

In deciding as to the eleemosynary projects, however, it is desirable that legislators and philanthropists should give the preference, other things being equal, to those institutions which save people with good inheritable qualities, running all others, as far as possible, on a celibate basis. The hospice for the goitrous in Aosta described by President Jordan, in which crétin mates with crétin, is a horrible perversion of charity to the service of degeneration.

Though civilization demands that lethal selection be reduced as far

as possible within the group, the possible rate of this reduction has been much exaggerated. In spite of all our charities 45 per cent. of the present generation die before the average age of marriage, indicating a great penalization of ignorance and immorality in the broad sense. As this selection is especially active among the physically unfit, these need not give so much concern to the eugenicist as the mentally and morally deficient. While we have no assurance that the children of the criminal and the imbecile will not live to hand down the curse, the weak and diseased are more likely to die out unless vitalized with fresh blood. The one exception is in the case of defectives in special senses, the deaf and blind, for example, being quite capable of perpetuating their defects through generations.

On the whole, lethal selection is attended with too much suffering and social sacrifice to be deliberately retained, but can never wholly disappear. We may always rely upon it to some extent as a weeder of the physically unfit, but the mentally and morally infirm are left to be dealt with chiefly by the projects of artificial selection previously mentioned.

CHAPTER V. *Sexual Selection*

While lethal selection shows a gradually decreasing action as we rise in the scale of evolution, and works by means generally opposed to civilization, the second great form of natural selection, that which acts not by premature death but by differential success in leaving progeny, reaches its greatest importance in man. Its first mode, sexual selection, has always been valuable in developing human aspects which lethal selection is powerless to invoke, including many of the esthetic and moral characteristics. Since it is not, like lethal selection, inextricably bound up with human suffering, it can be looked to whole-heartedly for progress. However, as this is a factor lying wholly outside the province of social control and within the bounds nearly universally left sacred to the individual, little has hitherto been attempted in the way of utilizing it in human evolution.

The influence of sexual selection is often belittled on the grounds that almost any man can marry and that love is often aroused by trivialities rather than worthiness. However badly it may work, however, its existence is proved by the fact that there are many people precluded from marriage by some obvious defects. Another very large group of inferiors, the criminals, tramps, paupers and prostitutes, largely substitute promiscuity for marriage, which leads to few births because of the consequent frequency of sterility and abortion. Those who marry are usually conscious of having made a selection from several, in spite of the fatalistic impression current in this field and finding voice in the proverbs "Marriage is a lottery" and "Love is blind."

Sexual selection, then, is an active force. The question is, Does this

selection work to insure the marriage of the fittest according to our best moral, mental and physical standards?

In the absence of any Bradstreet's of marriageability, we should be able to take our college graduates as a picked class, probably for all three ratings, and the indications here are not encouraging. According to the *Yale Alumni Weekly,* the percentage of married men in twenty classes, twenty years after leaving college, is estimated at only 61 per cent., less than two thirds. The annual report of the president of Harvard College (1901–2) gives for the classes of 1872–7, twenty-five to thirty years after graduation, 28 per cent. still unmarried, and Dr. G. Stanley Hall estimates that, while three fourths of the men graduates of colleges remain single for twenty-five years after graduation, one half of the women graduates are still unmarried after ten years.

Since, then, the marriage rate of men and women of education and achievement is below the average of the population, the eugenicist is at one with the advocate of social progress who seeks definite means to raise the choosing of a mate to a higher plane than at present. The aims are two—first to induce all the suitable to embrace matrimony, and second to make the choice as discriminative as possible of the characteristics most socially desirable.

Legislation is here out of the question, and the only hope is in a gradual modification of public opinion in regard to personal evaluations. That this is not a forlorn hope is shown by the changes that have already come about in sexual desirability, in response to social and esthetic progress. Women no longer require proofs of personal prowess in their mates, and masculine beauty possesses on the whole less attractiveness in our times than achievement. The criterion of feminine excellence has varied from the physical perfection of ancient times to the spirituelle attenuation of our grandmothers, and now fortunately back to a standard into which physique again frankly enters. We have some justification also in saying that the moral standard for masculine and the mental for feminine excellence have risen since the days of "Tom Jones" and "The Vicar of Wakefield."

While it is undeniable that love when once established defies rational considerations, yet we must remember that sexual selection proceeds usually through two stages, the first being one of mere mutual attraction and interest. It is in this stage that the will and the reason are still operative, and here alone that any considerable elevation of standard may be effective. There is in this book, therefore, no suggestion of substituting the planned marriage for the romantic, but merely of bringing the preliminary psychological stage of the latter under the control of reason rather than chance.

It is worth while, accordingly, to indicate some directions in which the public opinion of the twentieth century may well be modified.

Beauty of face still carries far too much weight as a desideratum for matrimony, but this quality is not without some eugenic value. Far more serious is the modern tendency to substitute for mere beauty another characteristic which, for want of a better name, we may term flashiness. In our sober moments we all recognize the flashy man or woman as *per se* inferior, but it is undeniable that, other things being equal, the matrimonial chances of this class are above, rather than below the average. There is hope in the consideration that this demand is largely artificial, stimulated by the press, the popular magazine, and, above all, the stage. A moment's recollection of the standard of sexual desirability displayed in the ordinary farce will illustrate forcibly the disparity between the artificial qualities there emphasized and the characteristics really desired by the general public in wife or husband.

Along with a shifting of values from this false emphasis there is needed the general cultivation of conscious selection, this again depending largely upon the attitude of the press and the stage. While a large percentage of our current witticisms inculcate the cynical, and many of our novels and plays, the fatalistic view of marriage, it is not to be wondered at that sexual selection still falls far short of the ideal.

Although an elevation of standard is of preeminent value not only for eugenic, but for social progress, it is obvious that too rigid a criterion might have the effect of leaving many desirables unmated. We must balance this tendency, therefore, by doing away with certain obstacles to free sexual selection which have hitherto worked to produce celibacy in superior men and women.

Social caste lines, for example, if closely drawn, tend to leave unmarried many individuals who, though unable to find mates in their own class, might easily do so in another: the diplomat's daughter whom propriety forbids to fall in love with her father's secretary, and the butler's daughter to whom exceptional endowment has made distasteful the suitors of her own walk of life, are alike the victims of convention, their line being extinguished in this way as effectively as if they were undesirables.

Extreme inequality of wealth has an even more unfortunate effect, as confining choice within limits much more arbitrary than those of hereditary class, and thus keeping possible mates in widely distant spheres. Such luxuries as the parlor car, the country estate and the many-barriered ocean steamer have fixed a gulf between the millionaire and the lower middle class that is seldom traversed matrimonially except through the medium of the stage.

While the legislative interests of the eugenicist and the social reformer here again coincide in their common opposition to extreme inequalities of wealth and rank, something may be accomplished even

under the present economic disadvantage by the mere enlargement of circles of acquaintance. All social functions that are not merely formal, but give opportunity for real acquaintanceship should be encouraged, in order that young people of both sexes may meet under favorable circumstances and frequently enough to admit of knowledge of and friendship with many individuals. Intelligent opposition to such functions is largely because of their restriction to narrow circles and their excesses in late hours, dress, food and decorations, none of these being essential accompaniments of social intercourse. The churches have hitherto done excellent work in this direction of social mingling, and the same may be said of the various organizations in which young men and women meet together for definite purposes.

That social intercourse is definitely recognized by the public as a means for rational sexual selection is shown in the series of letters to the New York *Times* through October, 1908, resulting in the proposed formation of the Lonely Club.

Since the college at its best is one of the last bulwarks of social and economic democracy, and affords our nearest approach to an environment unspoiled by convention, where individuals are given opportunity to display their true moral, mental and physical mettle, much may be expected from coeducation in the selection of the future. In the west, where coeducation is comparatively wide-spread, there is apparent a higher marriage rate among educated women than in the east, and a thorough investigation of such rates in educational institutions of both classes is needed to bring the attention of educators to this important matter.

The character of the college courses desirable for women is another point that must soon be considered in the educational world. It is quite possible that their too academic nature at present is partly responsible for the low marriage rate of women graduates, and that training more adapted to the needs of wives and mothers than to those of scholars and teachers should be adopted. The preponderance of women teachers in girls' colleges may be another contributing cause, in its setting up of ideals other than domestic.

Clerical celibacy in former times, continuing at present in the Roman Catholic Church, though instituted in the interest of the spiritual, has worked rather to the weeding-out of the gentle, the spiritual and the intellectual. Much of the decline in modern Spain and Italy may be ascribed to this custom, together with the prevalence in the past of religious persecution. It may not be wholly useless for the eugenicist to lift up his voice against this suicidal institution, for, soon some progressive pope, seeing that the practise is clearly detrimental to the interests of his institution, will set himself against it.

To the degenerating effect of modern warfare already mentioned

should be added the interference with sexual selection brought about by a standing army and navy, through which a large proportion of picked men are, for the best period of their lives, placed in an environment where immorality thrives and marriage is discouraged, if not absolutely excluded. The movement toward universal disarmament thus comes into eugenic favor, and, even at present, some reform might be effected by the abandonment of the practise of isolation of troops and the permission of soldiers to reside out of barracks, responding to roll-call at definite hours.

Among the many evils that follow in the train of sexual immorality may be mentioned the hindrance to sexual selection of the highest sort brought about by the corruption of the emotional nature, by which a man's choice when he eventually marries is likely to be far inferior to that which otherwise might have been possible for him. Here, once more, therefore, eugenics gives its hearty support to all movements for the raising of public morality.

A change in social values as to reputability and honor is greatly needed for the better working of sexual selection. The conspicuous waste and leisure that Veblen points out as our chief criterion of reputability have no necessary connection with mental or moral qualities, and, in the present somewhat illogical inequality of distribution, do not always bear a direct ratio even to the traits that make for genuine economic progress. On the other hand, the fact that the insignia of success are too often awarded to trickery, callousness and luck does not argue the abolishing of these signs altogether in favor of a "dead level" of egalitarianism. Distinctions, if rightly awarded, are an aid, rather than a hindrance, to selection, and effort should be directed no less to the proper recognition of true superiority than to the moderation of our excessive social differences.

Galton has devised a definite, if matter-of-fact method of establishing a better standard of social esteem. This is a plan of issuing certificates to such young persons as would voluntarily present themselves for examination and decimal evaluation, those reaching a higher standard to form a social elite naturally sought after as desirable husbands or wives. Though this scheme would be far from infallible, owing to the elusive nature of many characteristics, the difficulty of allowance for growth, and our ignorance of the exact laws of heredity, such a true aristocracy, would certainly possess great advantages over the present classifications of The Four Hundred, Daughters of the Revolution, hereditary nobility and social cliques. Even its somewhat humorous deficiency in romanticism arises largely from its novelty, since idyllic love seems to have survived the equally unpoetic institutions of the dowry, the license and the divorce regulations.

Valuable as are these suggestions, however, no mere device can ever

wholly take the place of a lofty and rational idea of marriage, to be brought about by an uplifting of public opinion. It is difficult to bring under the control of the mind a province that has for so long been left almost superstitiously to caprice, but much can be done, in an age of growing social responsibility, to produce a genuine respect and desire for marriage as a necessity to the complete life. More and more we see an appreciation of the immortality achieved by the training up of children to the betterment of the world.

Chapter VI. *The Distribution of Births*

Even if it were possible to attain the ideal working of sexual selection the task of eugenics is not completed.

Fecundal selection, or the principle of descent from those leaving the most numerous offspring, seems to be the most powerful influence in the contemporary evolution of mankind. Throughout the western civilization we find, between 1870 and 1880, the beginning of a marked decline in the birth rate, which, while affecting the backward races least of all, shows no signs of abating at present.

Among the causes of this decrease may be mentioned the more expensive standard of living in civilized countries, the competition of other than domestic activities, greater ambition for the child coupled with greater fluidity of social classes, and, last and most important, a greater knowledge of the physiology of reproduction and the prevention of conception.

Though this general decline in the birth rate gives in itself no special cause for alarm, the serious consideration is that this decline is distributed very unevenly through the social classes. Pearson brings out this point very clearly, the differential character being shown by the fact that in Copenhagen 25 per cent. of one generation is producing from 50 to 60 per cent. of the next. The personnel of this 25 per cent. is not encouraging. The analysis of Pearson, Heron and others for London shows that the decrease in birth rate is greatest among families of the highest income and social position, while Passy gives the birth rate for rich Paris as 1.9, of poor Paris as 2.8. Figures for the United States show that the decline affects American blood far more heavily than that of the immigrants, the Massachusetts birth rate in 1890 being only 2.4 for the native as against 4.3 for the foreign population. The old Puritan families are gradually disappearing—that of John Alden, for instance, will in the next generation be extinct in the male line—while the Finns, Portuguese and French Canadians are spreading over New England. College-bred men and women are apparently failing even to replace themselves, the married members of the Harvard classes above referred to, themselves but a small proportion, having an average of but two surviving children twenty-five years after graduation.

A glance at the causes as given above will explain this disproportion in the decline of the rate. It is the more individuated who feel the greatest interest in those activities which compete with child-raising, and the better informed who know the efficient methods of preventing the unwelcome child. The majority of large families at present are the result not so much of deliberation as of ignorance. As with the increase of knowledge and the complexity of civilization the situation is likely to become more pronounced, it is a pressing problem to ascertain by what means we may increase the birth rate of the superior stocks, and keep down at least proportionately the children of inferior blood.

There is need for a direct appeal to make child production a matter of religion and ethics rather than of mere whim, though too much must not be expected from it. A plea such as Roosevelt's, however, for indiscriminate large families is certainly uncalled-for, and "race progress" rather than "race suicide" should be the cry. If the decline in the rate were evenly distributed, it might not even be regrettable, for the old rate could not have been maintained indefinitely without undue pressure on the productivity of the earth. The only logical excuse for the Roosevelt attitude is the military one, but the favorable geographical position and commercial supremacy of the United States may save us from anxiety on this score, and the disadvantage of a rapidly growing population in greater poverty, poorer education and a slower rate of social progress is a far more important consideration for us at present.

The appeal for large families is of use only when directed especially to persons of superior ability, as from the innately inferior the fewer children the better. The average parents should replace themselves by bringing at least two children to maturity and marriage, four births in general being required for this result.

A most desirable means for limiting the families of the inferior, as falling in with the noblest efforts for social progress, would be the abolition of child labor. While every additional child in the lowest stratum of society may be made a means of profit within ten or fifteen years, we must expect the lazy and the incapable to multiply at the expense of those to whom the child is an object of care and sacrifice.

Another definite advantage in the redistribution of the birth rate would be gained by ceasing to treat as illegal the knowledge of the prevention of conception. Thus the ignorant would no longer be favored in fecundity, and a more reasonable proportion would result. Though it is true that the rate might in this way be brought somewhat below the point of maximum advantage, yet we should then, granting selected immigration, be placed in a position to build up the population by an increase of membership from the best stocks.

The divorce laws also might be made of beneficial effect. The eugenic value of divorce at present is that it removes from the parental possibilities of marriage certain individuals who are inferior in one way

or another, and that it permits a remarriage of some superior persons to better partners. In order to increase this action it might be advisable to extend the recognized grounds for divorce. Such defects as epilepsy, feeble-mindedness, extreme cruelty, moral perversity, repeated conviction for crime, or habitual drunkenness should be made of equal weight with unfaithfulness and desertion, as indicating innate inferiority rather than an "occasional crime."

Venereal disease, in so far as it causes infecundity among the vicious, may be regarded as a eugenic agent. In view of its great cost to society, however, the eugenicist should encourage every effort to stamp it out by education, medical control and the enforcement of social morality. While the vicious would, at best, only gradually become exempt, the innocent should at once be protected and society freed from the evil which now causes the sterility of 45 per cent. of its childless women.

The measures just mentioned, though important, do not effect the deplorable decline of the desire for children among the best men and women that is menacing the future. The work of Sir Francis Galton and Karl Pearson in England illustrates the efforts that should be brought to bear upon the enlightened classes to recognize the rearing of children as a duty to the race. Men and women should be made to realize the feeling of nothingness that is the portion of the childless in old age and the gratification that lies in living youth over again in one's children. The surest immortality, as well as the noblest fulfilment of life, is to be found in marriage and parenthood.

The strongest single influence in the voluntary limitation of the family is the complexity of modern life, with its abnormally high standard of expenditure. Not only does the selfishness of parents forbid any curtailing of personal extravagance for the sake of children, but parental love itself causes a restriction of the family to one or two, lest it be impossible to lavish upon a larger number all the care and luxury demanded by present-day standards. Dress, education and launching into life are all to be considered, and as a result we have the family too small to replace the parents and a stock that quickly dies out before the prolific immigrant peasant.

Both from the eugenic point of view and from that of the social reformer, there is need of an ethics of expenditure. As Professor Ross points out, a high valuation placed upon the things money can buy has as its reverse side, a low valuation of the things money can not buy—the integrity of the politician, the virtue of the woman and the ideal of the artist—and there is something alarming in the standard of "conspicuous expenditure" which sacrifices to itself both the souls of the present and the lives of the next generation.

A further result of the too extravagant standard is the postponement

of marriage until the young people can begin life upon the same plane as their parents, too often resulting in an abandonment of marriage altogether, and almost always in a limitation of the family. Why can not young men and women return to the simpler ideals of "love in a cottage" and leave ostentation, if it be necessary at all, to their elders? The French and Chinese custom of giving financial assistance to children during the first years of marriage is commendable as tending to perpetuate families of ability, but the method of bestowing dots has the counterbalancing disadvantage of reacting unfavorably upon the parents, by a restriction of the number of children in a zeal to enlarge the dowry.

Unfortunately those youths who are destined for the more exacting professions are now obliged to spend a long unproductive period in education. While the past generation of A.B.'s, after leaving college at about twenty, found immediately open to them some field of professional usefulness, the young man of the present is compelled more and more to supplement his bachelor's degree by some definite technical training, or, if he seeks livelihood in the academic world, he must usually add to his previous study years of advanced research. Marriage is thus unduly delayed among the young men of greatest social value. Our universities, in granting many fellowships too small for the support of a wife, are increasing this tendency. A practise far more favorable eugenically would be the bestowal of the same income upon fewer men and in amounts large enough to insure a living, increasing the sum with marriage and the birth of children.

The marriage of the finest young women, on the other hand, is often delayed and sometimes even prevented by an exaltation of the "career" at the expense of wifehood and motherhood. This striving, probably propagated more in radical feminist circles than in the colleges themselves, leads some women of the highest ability and character to remain celibate, or if married to be content with but one or two children. The various movements for the higher education of women, with all their furthering of social progress, are doubtless partly responsible by their emphasis on "culture" and neglect of the training for the work of wife and mother. The large proportion of women professors and instructors in the women's colleges has the unfortunate effect of exalting "careers" for women.

While due care must be observed not to lose sight of the qualitative principle in sexual selection, by an encouragement of too early marriages, yet it is clear that fecundal selection can work satisfactorily only when the superior men and women marry in time to more than replace themselves by their children.

The whole factor of reproductive selection, both sexual and fecundal, is, to sum up, a greater power in modern life than lethal, often called

natural, selection. Sexual selection, though operating somewhat more beneficially as civilization progresses, is still far from ideal, and needs to be placed upon a basis of ethics and judgment rather than caprice and convention. Fecundal selection is in a still more unsatisfactory condition owing to the steady diminishing of families among the better stocks and the consequent propagation of the race by inferiors. Though certain social devices would be of some advantage, our main hope again must be in raising the ethical standard, by placing child production as a goal of manhood and womanhood.

CHAPTER VII. *The Mission of Eugenics*

It has been shown that, while improvement of the race in innate quality is almost a *sine qua non* for permanent social advancement, the factors which make for it frequently fail to coincide with the influences tending toward social progress. Pearson says:

> Consciously or unconsciously, we have suspended the racial purgation maintained in less developed communities by natural selection. We return our criminals after penance, our insane and tuberculous after "recovery" to their old lives, and we leave the mentally defective flotsam on the flood tide of primordial passions. We disregard on every side these two great principles: (*a*) the inheritance of variations, and (*b*) the correlation in heredity of unlike imperfections.

The eugenicist urges, therefore, scientific investigation as preliminary to action. He proposes, first, that the registration laws of both federal and state governments be so amended as to make vital statistics reliable and comprehensive, and, second, that the students of biological and sociological laboratories be encouraged to wider and more accurate study of the laws of human heredity according to the methods of Galton and Pearson.

Like all contributions to the sum of social ideas, eugenics must work by the successive steps of invention, generalization and tradition, corresponding to the biological processes of variation, survival of the fittest and heredity. Invention, or discovery of the laws of eugenics, is here the part of the laboratory specialist, and should loom high in the attention of the sociologists of this generation.

We must not wait, however, for full knowledge before proceeding to the next step, for full knowledge can never be attained. The exact concontribution of the parents or degree of inheritableness need not be ascertained before we begin work, for we know already a certain number of characteristics possessing a high degree of inheritability. Though cattle breeders know little quantitatively of the inheritance of milk production, they have acted upon this little for many years with marvelous results; if, on the contrary, they had waited for elaborate statistical investigation and experimentation, we should now be using goats for milk instead of cows.

Not until tradition has played its part, however, can the schemes for eugenic reform become actual. As Professor Kellar reminds us, the folkways and customs of the race must be deeply affected before mere education and legislation can exercise an appreciable influence upon action, and such a change at best is slow, though permanent.

The immediate mission of eugenics becomes, then, the advocacy of all measures tending to race improvement and not involving heavy social cost, the examination of all proposed reforms from both the biological and the social points of view, and, perhaps most important of all, the creation of a new standard of ethics with regard to marriage and the family. It is time for American men and women to leave the vital subject of race progress no longer to social iconoclasm on the one hand and fatalist superstition on the other, but to consider it seriously and religiously, aided by the best resources of modern science, and then to give their support to such measures as may seem to them best, freed alike from flippancy, conventionality and sensationalism.

COLLEGE DIVERSIONS

By Professor JOHN J. STEVENSON
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THE phase assumed by discussions respecting athletics must bring great comfort to coaches and others who derive profit or glory from intercollegiate contests. They are to be congratulated upon the success attending their efforts to divert attention from the serious matters at issue and in concentrating it upon wholly irrelevant inquiries as to the alleged brutality of football.

It may be said in passing that a game which, in the short season just closed, can boast of 30 killed, 20 others fatally wounded, as well as nearly 1,000 more or less seriously injured, may be regarded as fairly brutal; but this is merely incidental: if parents choose to permit their sons to play football, that is their concern. The main issue is vastly broader and the dust raised about football is merely an attempt to conceal it.

If a visitor from some outside region should read the college papers, which are encouraged because they give young men an "admirable preparation for journalistic work in after life," he would be convinced that American boys in college think of little aside from professional sport. Appeals to college spirit abound, urging the fellows to attend the games and to bring their friends—to prevent a deficit in the treasury; lamentations are prolonged, deploring the lack of college spirit shown by muscular men who fail to apply for places on the teams; there are doleful predictions because students do not pay up for support of the several crews and gloomy forecasts abound because the college is in danger of losing its high standing. If a team has gained a victory, the paper is hardly large enough to hold the story; the work done by the coaches is extolled as entitling them to the everlasting gratitude of the college, for whose advancement they have done so much. It is true that the college professors are not forgotten; there are frequent references to them in connection with the formulation of new rules abridging still further the personal liberty of students.

If the visitor pass into the college buildings he might be led to believe that the professors themselves respect intellectual prowess as little as the students do. The walls are often decorated with trophies won in intercollegiate contests; the names of college champions shine out on the roll adorning the gymnasium, but he finds no roll of honor-men in the class-rooms; silver cups and medals of gold, silver or bronze abound for athletes, but prizes for men who excel in study are few and

insignificant; victory in the intellectual arena seems to count for little even with the professors; victory in contests requiring only such abilities as a savage possesses alone deserves permanent record in the shrine of learning. If this visitor go farther in examination of the college plant, he may find that great sums of money have been expended in acquiring athletic fields, in provision for comfortable seating of spectators; that buildings for physical culture often excel in equipment those for mental culture and that the coaches for teams in athletics are, as a rule, better paid for the time expended than are assistant professors or, in some cases, than even the professors. He will have little doubt that those who have control of college affairs think more highly of the extraneous courses than they do of the college curriculum.

Should this visitor turn to the great daily papers, he will discover that popular opinion coincides with that of students and college authorities. A page or even two pages may be devoted to description of a single football contest; for days beforehand, the betting odds are given and the police make due preparation to repress too great exuberance on the part of the visitors' sympathizers. But during the greater part of the year he will find little reference to any college work except that of intercollegiate contests. The pressure of interesting news prevents insertion of any but passing notes respecting the mental culture side—unless a professor make a statement, which, separated from the context, appears to conflict with some popularly accepted opinion concerning morals or social relations.

If this visitor should pursue his inquiries in detail, he would find that appearances do not belie the fact. He would discover that glee clubs give abundant concerts during the term time and that sometimes they even make tours; that the football season consumes two months or more at the opening of the college year, when men should be devoting their whole energy to study; that the baseball season is at its height during the closing weeks of the college year, when men are supposed to be grinding at the final reviews; and that the anxiety of young men to prevent too close absorption in study has led them to introduce basketball and hockey to fill the unfortunate gap which exists between the seasons of football and baseball. As if these were not enough, he would find careful provision for the needs of men indifferent to violent exercise; for them there are intercollegiate contests in chess and debating; there are "magazines," "newspapers," dramatic exhibitions—so many devices to entice men from their legitimate work that it seems impossible for any to escape the net.

If, after this investigation, the visitor should express the opinion that in a great proportion of American colleges intellectual development is subordinated to other matters, surely no one could censure him.

It is said that this is but a reaction from the conditions of former

days, when colleges neglected the physical welfare of students and devoted their attention so strenuously to intellectual work as to endanger the health of those entrusted to their care. This is hardly exact, for there never was a time in this country when the curriculum was so severe as to endanger any man's health; in any event, the study of alumni catalogues shows that in pre-athletic days college students were, as they are now, a selected class, with tendency to long life and were, on the average, excellent risks for life insurance. But whether or not the statement be true that colleges in former days neglected the physical welfare of students, the fact remains that they are doing little better now.

The plea for funds with which to purchase athletic fields and erect gymnasiums was successful and vast sums have been expended, far out of proportion to any possible good that might result. But what has been gained by the expenditure? Some colleges have a brief compulsory course in the gymnasium; but the great equipment is utilized more and more each year for teams composed of men whose bodies need no such anxious care. The vast majority of students must gain their physical culture by proxy, by paying generously toward support of the college champions, just as they must secure much of their esthetic culture by supporting publications or teams in chess and debating and by purchasing tickets to glee club concerts—all for the advancement of the college. The chances for neglect of physical culture are greater than formerly, as the pocket money which enabled the boys of other days to have their little baseball and rowing clubs is now consumed in purchasing admission tickets to concerts, contests and the rest.

The method in which defenders of intercollegiate contests have conducted their side of the discussion does no credit either to their manliness or to their integrity. Those who oppose the waste of time and the diversion of funds have been stigmatized as men indifferent to the health of students, as effeminate, as desiring that young men become "mollycoddles"; sneers have taken the place of argument. But the statements and characterizations are false throughout. By far the great majority of those who criticize the present deplorable condition are warm defenders of physical culture; they would be gratified if the course in gymnastics were made more extensive and compulsory, for they recognize that young men who need such training have no desire for it; they not only maintain that physical exercise, singing, chess playing, debating and the rest are commendable, but they assert also that such diversions are necessary for they are firm believers in the old adage that "All work and no play makes Jack a dull boy, they say." But they denounce the present system which has relegated study to the background and has made the proper college work merely an annex to exhibitions. That which is only incidential has been made all-important.

Men from foreign universities are astonished to find that Harvard, Yale, Princeton and other great universities are known to the public generally only as football associations; that the newspapers so rarely make reference to the eminence of men composing the faculties of those universities, that such references as are made are too often in the shape of squibs ridiculing statements charged upon them by irresponsible reporters. Little is said now about sitting at "the feet of Gamaliel" and apparently Gamaliel's race has disappeared. It is no wonder that the callow graduate of a few years' standing announces to the gaping undergraduate that he never derived any advantage from the professors and that his present greatness is due wholly to himself.

The effect on the morale of our colleges is increasingly bad; alumni of less than fifteen years' standing seem to think that they can show their love for alma mater best by a gift for a grandstand, a stadium or something else to increase interest in team exhibitions; the athlete is the college hero, the mere student is a "dig" without college spirit; worse than all, the new generation of college instructors has grown up in this atmosphere and favors continuance of the condition; appeals of a highly-paid coach or of the team manager do not fall on deaf ears when addressed to such instructors, who are not likely to check the growing tendency to lower the standard in favor of efficient athletes.

It is impossible to ignore the fact that this tendency exists. The college curriculum was arranged so as to require much time for actual preparation outside of the class-room; yet men, who during a considerable part of the college year are unable to give serious attention to study, succeed in "catching up" so as to pass examinations and in obtaining their degrees. The usual reply to this argument is that so-and-so, who was very prominent in sports, graduated at the head of his class and did well afterward. Very true. And the writer knows a man who, throughout his college course, earned his livelihood as night watchman for the custom house on a New York pier, yet graduated at the head of his class and made his mark afterward in the world's affairs. But to offer such men as representing the average student is as absurd as would be the assertion that Aristotle typified the Greek intellect or that James J. Jeffries typifies American physique. The average student finds much study a weariness to the flesh; glee clubs, athletics and the rest increase the weariness; they absorb the chief interest and there remains only a petty fraction of the original interest to be devoted to study. Other men, loving study quite as little, spend their energy in "rooting" for the team and they too receive their degrees.

But the matter of good faith must not be neglected. This wild craze for outside courses is of comparatively recent origin. The great funds acquired by our colleges were given for the training of the mind, not for the training of the body; the money for gymnasiums and the

rest was obtained originally on the plea that the student's body must be cared for that he may do better work with his mind. The colleges have not kept faith with the donors. The college is becoming an annex to the athletic field so rapidly that the absurdity of the relation affords the most fruitful source for newspaper jests; while the equipment for physical culture has been diverted from service for the great number to service for the few. Coaches are selected because of their well-known qualifications and are paid accordingly; college instructors are not always selected and paid on a similar basis.

Is the condition to continue and to grow worse? Certainly, unless those in control of our colleges change their conception of what a college should be. Denunciation of commercialism rings out in hoarsest tones from many a college rostrum and one might suppose that in our haunts of learning there is freedom from the coarse influence of the market. Yet nowhere is the so-called commercial idea more prevalent than in college management. The only conception of success seems to be growth in wealth and in number of students—quantity not quality. A great increase in the freshman class brings jubilation and a decrease leads to gloomy search for cause of the decay. This evil has brought about the present condition. Wandering glee clubs and successful teams gain much free advertising; the public reads the sporting pages and becomes aware that the college exists; boys in secondary schools learn which college has gained victories and they long to share in the glory. It "pays" to have coaches of high grade, well remunerated. But a faculty of men, competent and willing to give the best of teaching, would bring no advertising, would attract only a small class of students; the college would not become great during the lifetime of one man; it is not worth while to expend much on that which brings such small returns.

The present wretched condition will be changed when the control of college affairs has passed from the hands of men unacquainted with the actual needs and when it has been placed in the hands of those who know what teaching means and have respect for teachers.

THE THEORY OF STYLE

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ALTHOUGH signs of reaction are by no means wanting, the dominant form of criticism at the dawn of the twentieth century seems to be what is usually called literary impressionism. To keep his mind sensitized to all the influences his reading can bring to bear upon it, to disengage his impressions, and to set them forth in the choicest phraseology at command, are now recognized as constituting the supreme virtue of the critic. This attitude of impressionism towards literature is distinctly opposed to the literary dogmatism of the seventeenth and eighteenth centuries, and may be regarded as tending to supersede the subsequent phase, the so-called historical criticism, which traces calmly, if at times somewhat schematically, the evolution of poets and literatures, and even the more distinctly scientific criticism, which looks upon works of art as indices of the souls of artists and nations to be explained on the bases of esthetics, psychology and sociology. One remarks in all the more recent tendencies in literary criticism a certain degree of catholicity. Literature is no longer to be dogmatically approved or disapproved, but it is to be appreciated and *placed* according to recognized principles or a frankly individualistic point of view.

Of course impressionism is very far indeed from being democratic. Its high priest, the well-read, well-endowed, susceptible critic is still in some sense a public guide. He is a superior sort of camera, and a newly-acquired language may aid, like a new lens, to improve the quality of the impression. He starts, however, with no *a priori* principles of taste, and he may even be disdainful of esthetics. His desire for freedom from standards carries him perhaps too far in his contempt for theory. At any rate, it is not obvious that an emotionalistic esthetic which recognizes the conveyance and transmission of a mood as the essential of art is at variance with the spirit of genuine impressionism. In fact such an esthetic might ask, in view of the dearth of fixed principles, and the great stress laid in recent criticism on the mere ability to record impressions, whether literature about literature has not itself become art and renounced all claim to be called scientific. The difficult and tedious task of collecting and classifying impressions and striking averages and seeking bases of agreement from the broadest possible data is largely to be done before a science can be deduced from the mass of esthetic judgments.

Now, as a matter of fact, the great literary artists have possessed such a knowledge of the minds of their readers, such a skill in applying it to common human nature, as to at least ensure the popularity and in some cases the immortality of their works. The poet who feels that his verse will stand "to times in hope" speaks with a certainty that few formal doctrines can claim. Poets know by natural tact and through experiment the esthetic probability of achieving desired emotional effects by certain literary means. It is true that there are limitations to their success. Racine, Lamartine, La Fontaine, can never appeal to the English mind as to the French. Many well-equipped Germans will continue to find their translations of Shakespeare—for us grotesque—better—for them—than the original. The ultra-democrat and the moujik philosopher may be blind to the charm of Elizabethan art. Nevertheless, the greatest literary artists made their appeal not to the adventitious, but to the permanent in human nature, and a psychological study of their masterpieces should enable us to make explicit and doctrinal what with them was implicit and more or less intuitive.

Criticism itself has developed from a consideration of oratory. It was an attempt on the part of the rhetoricians to analyze the work of the orator with the intention of profiting by his successes and of taking warning from his failures. Some general theory of style is presupposed. The profundity to which this study was carried led to the clear recognition among the Greeks and Romans of the psychological significance involved in oratory and rhetoric. The orator is a philosopher with something added. The rhetorician must know the true and the false, he must understand the human mind even if his sole purpose be to deceive. The artist who ventures to play upon us must have a just appreciation of our tendencies and susceptibilities.

That recent rhetoricians take a less serious view of their vocation can be shown by a reference to their pages. One proclaims, for example, that "every piece of style may be said to impress readers in three ways—intellectually, emotionally, esthetically." This dictum forms the basis of a theory of style that cost its author ten years of study. A little further study along philosophical lines might have convinced him that a distinction between the emotional and the esthetic is not so radical as his classification implies. In fact, a glance at recent rhetorics might indicate that as far as the rhetoricians are concerned the same condition prevails now as Spencer complained of over half a century ago: No general theory of expression seems yet to have been enunciated. It was the desire to discover the psychological basis of the heterogeneous rules of the rhetoricians that led him to formulate his theory of the economy of mental energies and sensibilities. The little essay that sets forth his theory, refused by one magazine and dubbed by the editor of a second with the grandiose title Philosophy of Style,

would hardly call for serious comment, only that it is still highly praised by American rhetoricians and that Spencer in his publications of 1902 reaffirmed his belief in the conclusions reached by him in 1853, though indeed he confessed that the question of style had never by him been made a real object of study.

Spencer maintains that the desideratum that underlies the specific rules of rhetoric is to so present ideas that they may be apprehended with the least possible mental effort, and he proceeds to inquire whether economy of the recipient's attention is not the secret of the effect sought in the choice of words, their collocation, the arrangement of clauses, figures of speech and the rhythmical sequence of syllables. The short, familiar, imitative, specific, Saxon words are more forcible because they economize the reader's powers. The English idiom which puts the adjective before the noun is better than the French, because on reading the expression *un cheval noir* one tends first to think of a bay horse and an effort must be made to repaint the image, so to speak, while on reading *a black horse* the idea suggested by the adjective, being abstract, is suspended in its application until the noun gives us the substance for our concrete picture. On the same principle the predicate, which presents the subject under a certain aspect, must come first. *Great is Diana of the Ephesians* is more impressive than what is sometimes called the natural order. This theory of style is at first glance very plausible. That one should not waste mental effort seems obvious. But the more closely one examines it the more paradoxical does Spencer's so-called philosophy of style become. One feels this when he proposes to call the *inverted* style the *direct,* and the *natural* order the *indirect.* The philosopher himself is forced to recognize that his theory has limitations. It is not always the shortest epithet that is the most effective; *It is grand* may be less impressive than *It is magnificent.* Moreover, he confesses that beyond a certain point more is lost than is gained by the inverted order; the effort to carry in suspense is greater than that needed to correct a series of misconceptions in approaching the complete statement. He goes so far as to say "A greater grasp of mind is required for the ready comprehension of thoughts expressed in the direct manner, where the sentences are anywise intricate." This style admittedly demands a "considerable power of concentration." That is, it calls for a high degree of attention. Spencer says further "even when addressing the most vigorous intellects the direct style is unfit for communicating thoughts of a complex or abstract character."

In fact, as we proceed we find that this theory of style becomes hopelessly involved because of the failure to distinguish between clearness and force, and, again, between clearness and simplicity, and to recognize that style must suit itself not merely to different capacities but to different purposes. The theory's defects become apparent when

Spencer comes to consider figurative language. The main object of figures of speech is to bring one "more easily to the desired conception," that is, they tend to simplicity and clearness rather than to impressiveness and stimulation of the feeling. The metaphor owes its superiority over the simile to the great economy it achieves. Whately, on the other hand, had maintained that "all men are more gratified at catching the resemblance for themselves, than in having it pointed out to them." Spencer opposed this view. He probably recognized that underlying it was a principle that could be formulated in direct antithesis to his theory of style, *not economy of mental energies and sensibilities, but the greatest possible stimulation. Not the minimum of effort, but the maximum of response!* Attention is correlative with interest and it must be aroused rather than economized. It is not mere clearness of exposition, but the *power to evoke,* that is the supreme virtue of style.

Later in his essay Spencer stumbles on the secret of his so-called direct manner. "Mental excitement spontaneously prompts the use of those forms of speech which have been pointed out as the most effective." In other words, the inverted order is the emotional order distinguished by force, while the natural order is the intellectual order distinguished by clearness. When one reads what the essay contains concerning the economy of the mental sensibilities, the paradoxical character of the whole theory is greatly emphasized. Climax is more fruitfully described as an exploitation of the mental sensibilities than as an economy of the same. It is the cumulative effect of a summation of stimuli. What is the value of saying that antithesis and variety economize the attention rather than that they arouse the attention? The greatest possible emotional effect is the main purpose aimed at in the employment of the various figures of speech.

When Spencer comes to speak of poetry and proclaims its superiority to prose, into which view his brief for the inverted order leads him, there become marked the inadequacy and lack of discrimination of his whole theory of style. The principles that explain a prose style fail to account for a poetic style inasmuch as their purposes are different. To adopt Spencer's phraseology for a moment, economy of the mental energies is frequently at variance with economy of the mental sensibilities. Or, as I very much prefer to say, the appeal to the understanding is not always consistent with the appeal to the emotions; and in poetry clearness of expression is very often sacrificed to force. This conflict is apparent if we consider the question of rhythm. According to Spencer rhythmical structure is an economy of the reader's or hearer's attention. The strain required by the total irregularity of prose is diminished. If Spencer implies here by the indefinite word *economy* that the recipient's intellectual powers are utilized to the utmost and

the attention of the understanding is aroused to its fullest capability by the metrical form of poetry, I can not agree with him. Its very monotony tends to lull the discrimination to rest. If Spencer in explaining the value of rhythm means by economy of attention a failure to exercise the intellectual energies, he is inconsistent with himself. Yet in his account of the effects of rhythm I agree with him. In its soporific effect on the intellect, in its holding of the understanding in abeyance, lies the virtue of metrical language. Poetry is necessarily metrical because it is necessarily emotional. Spencer himself recognizes not merely, as previously stated, that emotion naturally chooses the bepraised *direct* order, but that the natural language of emotion is metrical if the emotion be not violent. "Whilst the matter embodied is idealized emotion, the vehicle is the idealized language of emotion," he says in speaking of poetry.

Before dismissing Spencer's theory of style let us make a further effort to render it plausible. In the first place the essay was written, not as a philosophy of style but as a study of the causes of force of expression. From this point of view it is comprehensible to proclaim the superiority of poetry to prose, to make much of rhythm, and to be a little transcendental in the application of the inverted order. Again, no one can gainsay the principle of economy clearly set forth and rightly applied. But it is misleading in the highest degree to use *economy* in a double sense, as *failure to exercise,* and as *exercising to the greatest possible advantage.*

Now, it is true that in both prose and poetry there must be the greatest possible economy of both the mental energies and the mental sensibilities. But in poetry economy of the sensibilities means their greatest possible utilization, and economy of the mental energies their comparative suspension and elimination. While, *vice versa,* the principle of economy as applied to prose demands economy of the mental sensibilities in the sense of their comparative suspension and economy of the mental energies in the sense of their utmost utilization. In other words in poetry clearness must at times be sacrificed to force, and in prose the emotional must yield to the intellectual impression. This opposition between clearness and force is based on the psychological fact that the emotions interfere with the judgment. Attention to the sensational aspect of an impression may blind us to the perception. The subjective mental attitude militates against the objective. When Spencer recommends the use of Saxon words—a recommendation which in 1902 he confesses not to have himself followed—and at the same time praises the use in prose of the inverted order, he is really regarding the subject from two points of view. The short, familiar Saxon word may bring us more readily to the idea, it may be perfectly clear and all the more so because not emotional. But "Great is Diana of the Ephe-

sians" is poor in its intellectual content, while it voices in the Bible story the ignorant fury of the populace. In the consciousness of this double aspect of the question Aristotle describes perfection of style as being clear without being mean. Now Saxon words tend to meanness and may, even on account of their simplicity, fall short of clearness. It is very obscure to say that an object is *round,* because *round* may mean *circular, spherical, cylindrical, discoid,* etc. Similarly Saxon words may be simple at the expense of clearness and precision. It seems perfectly natural that Spencer should find the language of the twelfth century inadequate to the needs of the twentieth. But even when clear, the Saxon, perhaps on account of its very familiarity, lacks the distinction that Aristotle recognizes as a requisite of perfect style. Choice of words is largely a matter of context, but *magnificent* may be preferable to *grand* or to the Saxon *great* on many grounds, among which its emotional suggestiveness should not be neglected. At any rate the attempt to hold university men of the twentieth century to the vocabulary of the subjugated portion of the population of England in the twelfth and thirteenth centuries is an absurdity that no theory of style can sanction, whether it lays emphasis on clearness, force or elegance.

More important than the mere choice of words in lending elevation and distinction to language is the use of figurative expressions. In the words of Aristotle "the greatest thing by far is to have a command of metaphor. This alone can not be imparted by another; it is the mark of genius—for to make good metaphors implies an eye for resemblances." Spencer similarly recognized that genius naturally tends to produce that style of composition which on analysis proves the most effective. The kinds of sentence which are theoretically best are those generally employed by superior minds, and by inferior minds *when excitement has raised them.*

When we regard the theory of style from the standpoint of recent psychology, a whole series of problems are seen to be involved—the nature of literary genius, association by similarity and its relation to the feelings, and connected with all these—and offering, perhaps, the best point of attack for our present purpose—the functioning of the creative imagination.

One might expect some light on the workings of the imagination from those who approach psychology from a pragmatist position and especially from such as treat the genetic and functional phases of psychology, particularly in view of the part played by the imagination in shaping our conduct—a part so great that we may be said to rehearse in imagination our vices and virtues before putting them into practise. In fact, the justification of recent psychologists in retaining the classifications and subdivisions of faculty psychology would seem to be the hope of confirming popular convictions in reference to mental science

and of showing how the memory, will, reason and imagination contribute in their functioning to the needs of the organism. Such expectations still lack something of fulfilment. Chapters on the imagination continue to give a large, perhaps undue, proportion of space to the discussion of imagery. Works on psychology that confess a disposition to make the functional their text are disappointing and inadequate in their treatment of the imagination. In this field we may confidently await fresh developments, as functional psychology, pushed far enough, should tend to bridge the chasm between a dry science of the states of consciousness as such and a vital knowledge of human nature.

A psychology genetic other than in name may enable us not merely to realize the part played by the imagination from the dawn of psychic life and its contribution to the physical and social adjustment of the individual, but also to trace the connection of this faculty—I venture to write the word without quotation marks—with the life-preserving and life-promoting emotions.

It would be rash to claim that *recognition* in the lower animals implies imagery and that consequently all progressive adjustments, such as form the criteria of intelligence, imply the exercise of imagination. In fact, the indefiniteness of our conception of our own images when we speak of gustatory and tactual imagery, and the increasingly impalpable nature of the conception as in comparative psychology we descend the animal scale, make apparent in this matter the futility of all dogmatism. But it seems certain that growth in intelligence is correlative with the breaking up of the total situation, to which the animal reacts, into disparate and independent images, which can be grouped and elaborated after the manner of, in judgments, the later concepts. This means the gradual displacement of association by contiguity through association by similarity, which culminates in the imaginative constructions of genius.

This development of the consciousness is naturally most marked where the need of adjustment is most imperative. At this point of vital interest the feelings also are naturally engaged, and consequently an intimate relation is to be expected between the imagination and the feelings. We need not pause now to consider the interdependence of the functioning of the imagination and the genesis of the emotions. If necessity is the mother of invention, fear, anger, sympathy, pride and love in their various guises bring it to birth. *The inner connection between the emotion and the imagination seems to lie in the kinesthetic image* or, as some might prefer to say, the kinesthetic sensation. Here the distinction between image and sensation is hard to make. Introspection reveals that all perception is accompanied by kinesthetic sensations from the eye, ear and other organs of sense. The corresponding visual, auditory and gustatory images have also a kinesthetic accom-

paniment. Needless to say, the kinesthetic image is similarly accompanied and an extraordinary power of introspection would be required to observe a distinction.

The close association between the motor sensation and the affective phases of consciousness betrays itself in the terms used to indicate the latter. The following may be cited: *émotion, Gemütsbewegung, commotion, répulsion, aversion, Abstossung, agitation, Unruhe, moving, stirring, aufregend, rührend, erschütterend* and *émouvant.* Even *touching* and *touchant* (duco) might be added, though in them as in *das Gefühl, le sentiment* and *feeling,* the tactual predominates over the kinesthetic as the fundamental idea. The fact, however, can not be ignored that *feel* and *toucher* mean *to pass the hand over* and have consequently an important motor implication.

It is not then surprising to hear it maintained that the kinesthetic (strain and relaxation) is a necessary ingredient, not certainly of feeling-tone, which, though it depends upon sensory and ideational activities, can not be analyzed into motor elements, but of the complex emotional state, of which the feeling tone, or affection, is the characteristic feature. Whether the physiological complex that gives an emotion its special value can be analyzed into merely three pairs of elements, strain and relaxation, exaltation and depression, the agreeable and the disagreeable, or whether other ingredients might be mentioned, as the secretions and excretions and the cerebral circulation, the part played by the first pair is undoubted. In fact from the genetic point of view it might have been anticipated that the sthenic emotions would be accompanied by muscle strain and the asthenic by a corresponding relaxation; so much of the physiology of both fear and anger can be explained in terms of preparedness for action.

The value of such a view for the present study is that it enables us to trace the relation of the emotions to the imagination. The kinesthetic element forms, on the one hand, part of that physiological complex which gives to emotion color and zest, while on the other hand it supplies material for imaginative elaboration and renders more vivid imagery from other sensory sources. *In fact it is solely the presence of this element of feeling that distinguishes the imagination from the understanding.* The image, the raw material of the one, differs from the concept, the raw material of the other, just in that vividness which an accompanying kinesthetic sensation is able to impart. Moreover, a critical examination of an imaginative masterpiece will reveal, that a poet is guided by his feeling in the choice of subject, in his selection and rejection of the aspects of the theme which are to receive emphasis, in his use of phraseology and epithets—in fact, in the employment of all the devices of poetic art. The conveyance of a mood is the substance of art. For this contribution to truth we stand indebted to an emotional-

istic esthetic. Now it must be added that *this conveyance of a mood is just the function of the artistic imagination,* as can be illustrated by an investigation of a poetic treatment of historical material. All additions, all subtractions, character-groupings, emphasis, subordination, retardation and precipitation of the events of the plot, local color and diction—everything that makes the finished product a work of the imagination—is brought about through the selective power of the mood to be conveyed. Painting would furnish similar examples of the working of the imagination. The feeling of exuberant exultation interprets for me Böcklin's "Im Spiele der Wellen"—the grotesque forms, the color scheme, every tint and shade, the atmosphere, every detail. Again, the feeling of dauntless resolution is the key to Dürer's "Ritter, Tod und Teufel." From the point of view of the mood to be conveyed nothing in the picture seems superfluous or irrelevant. The feeling guides the imagination of artist and connoisseur.

The view here maintained of the interdependence of the artistic imagination, the feelings and the kinesthetic elements of consciousness finds further confirmation when we consider esthetic appreciation as accompanied by a sympathetic imputation of our states of consciousness to the object contemplated, whether this be a part of nature or a work of art. This ascription of our motor states lies at the basis of personification and dictates the terms of imaginative description. Columns and spires and mountains are felt to *rise* majestically, or the headland *frowns* with beetling brows, the landscape or the sea *smiles,* and the sun *laughs* a pitiless laugh. It is a commonplace of psychology that the imaginative use of terms like *sweet, bitter* and *sour* is explained by the similarity of the physiological concomitants of certain affective states and of certain gustatory sensations. Of these similar concomitants the kinesthetic element constitutes the important feature. A sudden grief that we would regret and cast from us is *bitter,* months of deferred hope and suspended activity the poet describes as *sour.* That this sympathetic imputation of our own states of consciousness to the object contemplated involves, not merely imaginative and kinesthetic elements, but also an emotional element, is best indicated perhaps by the German word *Einfühlung.* This term expresses far better than *imputation,* or *inner imitation,* or *illusion,* or *conscious self-deception,* the attitude of the mind at the moment of esthetic appreciation. I ascribe its superiority to its recognition of the feelings as the basis of artistic satisfaction.

The close relation between the poetic imagination and the feelings is also seen when we consider that conditions that reduce to a minimum the perceptions, and the activities of the critical understanding, arouse both the feelings and the imagination. In dreams, in reveries, in visions of the night, at twilight, upon vague, obscure, ambiguous, sen-

sory stimuli, they are set in motion. Mists, echoes, clouds, moonlight, shadows and reflections play a great rôle in poetic art. A faint perfume or the sound of a distant bell may bring a scene before the imagination with almost hallucinatory vividness. A slight sensory hint like the song of a bird heard in the heart of London may have such reminiscent power as to kindle the feelings and imagination so as to transform the dust into mist, the street into a stream, and the buildings into hills and mountains. That poets are especially subject to these illusory influences the investigations of Professor Dilthey serve to demonstrate.

It is the vague and indefinite in nature that calls forth the feelings and affords scope for the exercise of the imagination. Similarly it is the suggestive power, the alluring ambiguity, of poetry that constitutes its great charm. *Not clearness, but obscurity, is the supreme virtue of the poetic style.* Our study, then, of the creative imagination confirms the view, arrived at in the first part of the discussion, that economy of the mental sensibilities is frequently at the expense of the economy of the mental energies. To get the greatest possible emotional and imaginative effect the understanding must in literature, as it is in music, be held largely in abeyance.

Besides this general question of the theory of style, which lies at the basis of literary criticism, many others of course call for psychological treatment. The psychiatrist already speaks with authority in reference to the portrayal of abnormal characters in literature—cases of congenital paresis, senile dementia or *folie du doute;* the psychologist should speak no less decisively in reference to types of normal character and their development. In fine, hardly a question raised by literary criticism would fail to be elucidated and advanced by expert psychological investigation. Certainly, if criticism is to be rescued from its present state of mere impressionism and placed on a scientific basis, the psychologist must share in the task.

THE TRANSMISSION OF DISEASE BY MONEY

By A. CRESSY MORRISON
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THE demonstration of a few of the avenues by which infection is transmitted is among the triumphs of modern experimental medicine. By its revelations cholera is now known to be mainly a water-borne disease; likewise it is recognized that typhoid is transmitted by those means by which the waste products of an infected individual are transferred either directly or in round-about ways to the food of another; malaria is no longer thought to be wafted by the night air, but is known to be directly carried to and introduced into the system by the mosquitoes; and, even a later triumph, yellow fever is seen to approach its human victim through the same hosts; while, finally, it has been determined that bubonic plague, the scourge of the tropical east, is carried by the rat flea. Notwithstanding these recognized avenues of transmission in specific instances, many other and more common infections continue to travel from one to another by paths that we do not know.

Before the knowledge of cholera transmission by water, it would have been considered a scientific contribution to the subject to have demonstrated the absence of cholera germs in twenty-four samples of water taken at random some of which perhaps were dirty; but to-day we know that the bacteriological study of water for evidence of cholera will usually demonstrate the avenue of infection only when and where cholera is prevalent. Similarly, it would be a matter of the greatest surprise if the examinations of twenty-four or many more samples of water or food for typhoid germs revealed their presence, even if the water or food was dirty and offensive. Likewise, the most diligent search of twenty-four or more mosquitoes for malaria or yellow fever would in all probability fail to show a single malarial plasmodium or yellow fever bacillus. In the same way, hundreds of rat fleas might be caught and made to bite guinea-pigs or rats without the production of bubonic plague in a single instance. Do any of these negative observations disprove or discredit in the least degree our present views on the origin of the various diseases whose avenues of infection we have mentioned?

By what privilege then does our scientific friend, Warren W. Hilditch, of the Sheffield Laboratory of Bacteriology and Hygiene, Yale University, claim in THE POPULAR SCIENCE MONTHLY of August, 1908, even the least knowledge of the transmission of disease by money from the bacteriological study of twenty-four bills, "the dirtiest I could obtain from various sources, such as railroad, trolley and theater ticket

offices, banks, drug stores and individuals in different part of the state"? When the facts of the transmission of cholera and typhoid by drinking water were discovered it was not by the demonstration of the corresponding germs in water, dirty or otherwise, which was taken at random. Indeed, these demonstrations were the last and most difficult steps in the whole chain of evidence and were only successful directed to water known to have been closely associated with epidemic outbreaks of the disease. By what reasoning, then, may we expect any more ready demonstration of infected money and why should not the same outside evidence of the possibility of infection guide as in the selection of money samples to be examined? Likewise, the demonstration of malaria in mosquitoes and bubonic plague in fleas was the last, not the first step in the chain of evidence, proving the avenues of infection of these diseases. The possibility and even the probability to a high degree were previously established by other evidence so that the material examined was advantageously selected.

Precisely as with cholera and typhoid the examination of water casually selected offers practically no opportunity of proving the transmission of these diseases by the demonstration of their specific infective organisms in the samples; exactly as with malaria, yellow fever and bubonic plague the examination of mosquitoes and fleas selected at random offers no promise of proving the transmission of these diseases by these hosts; so the examination of 24, of 240 or even of 2,400 bills not selected with intelligent appreciation of the opportunity for infection will contribute nothing at all to the solution of the transmission of infection by dirty money.

Great saving of human suffering and even life has resulted from triumphs referred to; likewise, the closing of other avenues of infection will certainly act as a prophylactic measure in regard to other infections. It is particularly desirable to discover the transmitting media of the more common but no less fatal organisms, such as the germs that infect the respiratory passages, notably the germs of colds, grip, diphtheria, pneumonia and tuberculosis. It is probable that the avenues of transmission of these germs are limited as are those of the diseases already discovered. It is, therefore, much more difficult to demonstrate the exact part that any particular avenue plays in the transmission. That dirty money, which, according to Mr. Hilditch, of the Sheffield Laboratory, Dr. Park, of the Research Laboratory of the Board of Health of New York, found to be "similar to other paper and rags and capable of carrying living tubercle and diphtheria bacilli for some days or longer," plays an important and unfortunate part in such transmissions is not only highly probable but is rendered more so by the very conditions found by Mr. Hilditch on the twenty-four bills selected by him from various sources, none of which is known to have had any direct connection with infectious material.

Examinations of drinking water for the agents of cholera or typhoid infection is so laborious and negative results are of such uncertain value that bacteriologists do not ordinarily make use of the direct isolation and identification of the specific germs of the disease in determining the purity of a given water, but rather look for indirect evidence of pollution which may be determined with more certainty and which is accordingly of greater negative as well as positive value. This evidence ordinarily consists of the identification of the colon bacillus, the recognition of which is certain and the presence of which signifies the contamination of the drinking water with material in which the colon bacillus is a normal inhabitant, namely, with human or animal waste. The demonstration of colon bacilli, then, constitutes proof of pollution of the water in a way that makes the introduction of cholera and typhoid germs possible. Even if they are not present, the way is open for their introduction at any time and the water is accordingly unfit for consumption.

It is desirable, it seems to me, to apply precisely the same principles to money. Mr. Hilditch has demonstrated that the average number of bacteria in each of twenty-one bills was 142,000, while by far the most common forms present were the varieties of the pyogenic staphylococcus. These organisms were not in possession of their full virulence but merely produced a more or less local reaction, on guinea-pig injection, with swelling of the lymph glands of the groin. Their constant presence on money is certainly of greater significance than merely indicating the exposure to the bacterial contamination of the air; they clearly indicate that the money has been contaminated by handling and without regard to the virulence or the danger of infection to which these particular organisms themselves expose those who receive the money, they establish beyond question the most fundamental and significant fact for scientific demonstration, viz., that *money is a medium of bacterial communication from one individual to another.*

Upon the question of the communication of highly infectious organisms, scientific evidence should now be sought by competent examinations of money known to have been exposed to sources of such contamination. It is not enough to know that much of the money in circulation is merely dirty; it should be known whether it is or is not a medium of the transmission of disease where such disease exists to be transmitted. From the contributions of Mr. Hilditch it appears that the handling of money infects it; from the observations of Dr. Park it appears that the germs of diphtheria and tuberculosis may live on bills infected by these germs for several days or longer. It seems but a step, then, to the final demonstration of the actual transmission of these and similar diseases by money in circulation and to the prevention of such spread of disease by the proper measures to eradicate such possibilities.

HOW COULD AN EXPLORER FIND THE POLE?

By Professor HARRY FIELDING REID
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THE claim to have reached the north pole, a point sought for several hundred years by many intrepid explorers, must, of course, be substantiated by adequate proof; and it may interest readers of this magazine to know what kind of proof is possible and necessary, and what observations the explorer must make to determine his geographical position when he is in the neighborhood of the pole.

Let us say, in the first place, that neither photographs, which only show the condition of the ice, but do not indicate whether they were taken near the pole or several hundred miles from it, nor the testimony of human beings, gives any evidence whatever that an explorer has been to the pole. Persons who were not actually with the explorer can only express their confidence in his good faith, in his knowledge of the proper astronomical observations to be made, and in his ability to make them with sufficient accuracy. Persons who accompanied him could only vouch for the fact that he did not remain in camp at a comfortable distance from the pole and manufacture observations, but that he actually traveled in the general direction of the pole, that on a certain date he claimed he was there, and that he made frequent astronomical observations on the route.

The only evidence which can at all satisfactorily show that an explorer has been near the pole is that afforded by observations on the sun or stars, capable of determining his successive positions at the times they were taken. Other evidence might prove the negative; such as inconsistencies in the narrative, inadequate time or insufficient food for the distance traveled, the description of phenomena which could not have been seen at the place where the explorer thought he was; and so on. It is impossible to foresee the many discrepancies which might show that an explorer has not been to the pole; they will not be considered here, as this article is not controversial, but merely aims to set forth, as simply as possible, what kind of observations must decide the claim of having reached the pole.

Confining our attention for the moment to observations on the sun, for the sake of simplicity of statement, we may say that the determination of one's position anywhere on the earth depends upon measuring the altitude of the sun above the horizon at two times, the second being, preferably, after the direction of the sun has changed by 90°. This becomes clear if we consider Fig. 1. Let us suppose the sun is

in the direction S and is immediately over the point A of the earth's surface. Its altitude there is 90°. As we pass along the earth's surface away from A, the direction of the horizon continually changes and the altitude of the sun continually diminishes until we reach the great circle, BC, which divides the light from the dark hemisphere, and there the sun is on the horizon and its altitude is zero degrees.

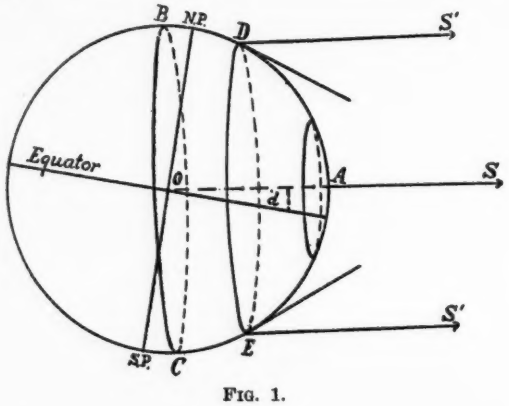


FIG. 1.

As the earth is spherical, and therefore symmetrical round the line OS, if we draw a circle DE on its surface, with its plane at right angles to this line, the altitude of the sun, as seen from all parts of this circle, will be the same; at the point D this altitude will be represented by h, the angle between the direction of the sun DS' and the horizon; for the sun is so distant from the earth, that its direction is the same from the center of the earth and from any point of the surface, to the degree of accuracy required by explorers. Every part of the circle DE is at right angles to the direction of the sun. The altitude of the sun changes with, and is determined by, the distance of the circle DE from A; and, *vice versa,* if the altitude is known, the distance of the circle from A is determined. The point A, itself, is fixed when we know Greenwich time and the angular height d of the sun above the equator; this latter is called the *declination;* it is continually changing, but its value at any time can be found in the "Nautical Almanac." An explorer would always take with him a copy of this work or an abbreviation of it; and he would also be supplied with chronometers keeping Greenwich time.

If an explorer has measured the altitude of the sun, and has at the same time observed the Greenwich time by his chronometer, he has merely determined that he is somewhere on a certain circle, whose position he could plot on his map; but other considerations, such as his last determined location, and the approximate distance he had traveled from it, would make known more or less roughly in what part

of the circle he was; but he could not determine his position accurately. If, some time after his first measure of the sun's altitude, he should make a second similar measure, he would determine his position on a second circle; and the intersection of those two circles would determine his position completely. The determination, of course, would be more accurate if the circles cut each other at a high angle, and this could be insured by making the second set of observations on the sun after it had changed its direction (measured on the horizontal plane) by about 90°. Instead of making two sets of observations on the sun, we might, in the evening, observe two stars properly located with respect to each other, and we could then find two circles of position in a few minutes and completely determine our position.

If the sun is due north or south the part of the circle on which the observer is will coincide with his parallel of latitude, which is thus immediately determined; if the sun is due east or west, a part of the circle will correspond with the meridian and the longitude will be found. The old method of determining position at sea, and one still in use, was to observe the sun at noon for latitude, and to accept as local noon the poorly determined time when the sun reached its highest altitude; or to observe also in the morning or evening for time or longitude, guessing at the latitude to work out the observations. But the new method makes it possible to observe altitudes at any time and to get satisfactory results even if the sun were hidden for several hours during the middle of the day. And besides it makes clear just what information regarding our position is yielded by a single observation of the sun's altitude. This beautiful method was first used by Captain Thomas H. Sumner, of Boston, Mass., in 1837; the short parts of the circle which are drawn on the map in finding one's position are called *Sumner's lines.*

If an explorer were approaching the north pole, and had arrived, let us say within a degree of it, it would be necessary for him to determine his latitude in order to know his distance from the pole, and to determine the direction of the pole in order to know his course. It might be supposed that when approaching the pole he would, by means of his compass, be able to follow his meridian; but the difficulty of keeping a fixed direction when traveling over rough ice, and especially the shifting of his position by the unknown drift of the ice, would soon make a decided change in his longitude in a region where the meridians converge so rapidly.

In the neighborhood of the north pole the compass needle points approximately in the direction of the meridian 155° west of Greenwich, according to Neumayer, but the angle between the needle and the meridian changes considerably for comparatively small variations of position; especially as the distance from the pole becomes smaller.

The North Star, so closely associated in our minds with the pole, would be of no use to the explorer, for it is about a degree and a quarter from the pole, and, like the other stars, it would circle around the observer, and at times even be directly south of him. To determine its direction the explorer would have to know his own latitude and local time; moreover, it would be invisible if the sun were above the horizon.

By means of his chronometer, keeping Greenwich mean time, the explorer could determine the direction of any meridian, for the sun would be on the meridian of Greenwich at Greenwich noon, and would move 15 degrees in longitude for every hour thereafter; this knowledge would be very valuable to enable him to lay out his return course from the pole to his base of supplies, but it would not, in ignorance of his meridian, help him to find the pole; for the direction of the pole in relation to the direction of the sun, or of the compass needle, does not depend upon the general direction of the meridians, but upon the particular meridian on which he happens to be.

We have thus the apparent anomaly that the same observations would enable a person to set a satisfactory course away from the pole, but not toward it. But the anomaly is only apparent; for, suppose the base of supplies were on the 70th meridian and in latitude 83°; and suppose the explorer were near the pole and twenty miles from the 70th meridian, on one side or the other; he could lay a course parallel with the 70th meridian and this direction would only differ by about a third of a degree from the most direct line to his base of supplies; but if he kept this course accurately, he would miss his base by twenty miles. This, however, would be less important than missing the pole by the same distance.

The very simple method of determining latitude by the altitude of the sun when on the meridian would not be available to the explorer, for his meridian would not be known; and it would require a set of observations extending over several hours to learn when the sun was on his meridian. On the sixth of April the sun would circle around the horizon, at an average altitude of about 6¼ degrees, and would only be two degrees higher at midday than at midnight, as seen by an explorer one degree from the north pole, provided its declination were constant; this, however, is not so; but on the date mentioned we should find, superposed on the variation in altitude due to the rotation of the earth, a steady increase in altitude amounting to a little more than a third of a degree in a day. On April 21 the sun's altitude would be about 11¾ degrees above the horizon, and the variations in altitude during the day would be almost the same as on the earlier date.

To determine his position, and the direction of the pole, the ex-

plorer must fall back on the method of Sumner's lines, and fortunately they can be applied with special facility in the neighborhood of the pole.

Let us suppose then that an explorer is approaching the north pole in the neighborhood of meridian 120 degrees. (See Fig. 2, where the outer circle represents a circle one degree from the pole, and the radiating lines are the meridians, 0 degree being that of Greenwich.) He determines the altitude of the sun when by his chronometer, let us say, it is in longitude 30 degrees. He now works out his latitude on the supposition that he also is in longitude 30 degrees; suppose his results give an apparent altitude of 89 degrees 50 minutes. He lays off that latitude on the 30th meridian at *A*, and draws a straight line

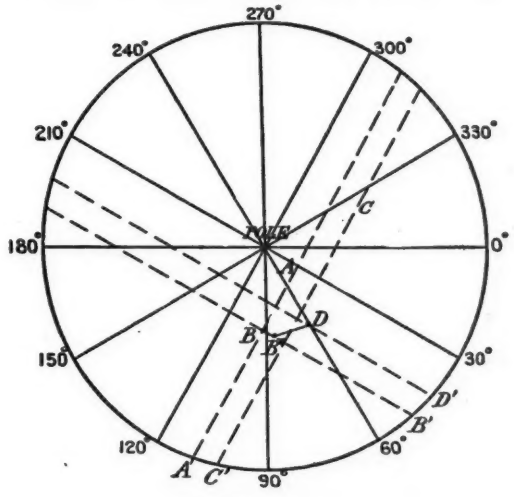


FIG. 2.

AA' at right angles to the latter; this line will practically coincide with a part of the circle at all of whose points the sun has the observed altitude at the time the observations were made; his position is therefore somewhere on this straight line, and, guessing about how far he has traveled from his last determined position, he can estimate roughly where he is; but if bad weather has prevented observations for several days, or the unknown drift of the ice has been strong, he might be many miles wrong.

If he should wait for six hours and make another similar observation of the sun's altitude when it is on the 120th meridian, he would determine a second line on which he would be; his true position would then be at the intersection of these two lines. If the second observation determined an apparent latitude of 89 degrees 40 minutes, he would lay off this latitude on the 120th meridian, draw a straight line, *BB'*, at right angles to the latter, and his true position would be at *B;*

this is about 22 minutes, or about 25 English miles, from the pole, and nearly on the 90th meridian. He now knows his position, and by the Greenwich time and the position of the sun he knows the direction of the 90th meridian, and therefore of the pole.

He then travels in the direction of the pole, keeping this direction by means of his compass or by the sun and his chronometer. Knowing about how fast he travels, he knows when he is in the immediate neighborhood of the pole, and he checks his position again by another pair of observations similar to the last.

Suppose, however, the drift of the ice has been quite strong; it may have carried him several miles from the line *AA'* during the six hours between his observations; at the time of the second observation he would, indeed, be on the line *BB'*, but he would no longer be on the line *AA'*. If he should wait another six hours and observe the sun when on the 210th meridian, he would then find himself, let us say, on the line *CC'*; and, assuming a uniform drift of the ice, his position at the time of the second observation would have been on the line *BB'* half way between the lines *AA'* and *CC'*—that is, at *B''*; but he has drifted away from the line *BB'* during the six hours since he determined his position on that line, and he does not know exactly where he is on the line *CC'*. If he waits six hours longer, and observes the sun when on the 300th meridian, and then finds himself on the line *DD'*, his true position at that time will be at *D*, and the drift of the ice during the twelve hours between his second and fourth observations will have been in the direction *B''D*, and it will have drifted a distance equal to the length of the line *B''D* on the scale of the figure.

An explorer may find his position by pure calculation, and may not use the graphic method described, but the principle in the two methods is exactly the same, and the graphic method shows more clearly what the observations mean.

An important source of error enters all these observations, namely, atmospheric refraction, or the bending down of the light rays as they pass through the atmosphere. The amount of this bending increases rapidly as the sun is nearer the horizon; it also varies with the barometric pressure, and with the temperature. On April 21, 1908, the sun was only about 11¾ degrees, and on April 6, 1909, only about 6¼ degrees above the horizon at the north pole; on both dates the refraction was considerable, and it is hardly well enough known to prevent errors of several minutes of arc in the determinations of position. If, however, the observer should wait for twenty-four hours after his first observation and should measure a fifth altitude of the sun, he could find a fair correction for the refraction and greatly improve the determination of his position.

It would be unreasonable to expect an explorer, making a dash for

the pole, to remain twenty-four or even eighteen hours at one camp for the purpose of exactly determining his position. By making daily observations on the sun, at different hours, so as not merely to fix his successive positions on a series of parallel lines, but on lines having different directions; by keeping his direction with the compass and estimating the drift of the ice and his rate of travel, he could always know where he was without too large an error. But when he was in the immediate neighborhood of the pole he should make as many observations, with the sun in different directions, as circumstances would permit.

Fatigue, severe cold, the condition of his commissariat, and the anxiety to return after having succeeded in his bold undertaking, might prevent him from making as many observations as would be desirable; but nevertheless they might be sufficient to be convincing that he had been within a few miles of the pole; it would surely be a quibble to dispute with an explorer the honor of having reached the pole if his observations showed, without reasonable doubt, that he had been within ten or fifteen miles of it.

There are two kinds of instruments used for measuring altitudes; the transit-theodolite and the sextant. The former consists of a telescope so mounted that it can turn in a vertical and in a horizontal plane; it is provided with vertical and horizontal graduated circles, to measure the angle turned through, and with leveling screws and spirit levels to adjust it in position. It is supported by a tripod, and after being properly leveled, the reading of the vertical circle gives the altitude of the object sighted through the telescope. It is by far the best instrument for an explorer on land, because it is very easy to use, and its adaptation to measure horizontal angles enables the explorer to carry on an ordinary survey.

The sextant was originally invented for use at sea, where a steady support can not be found. It consists of a telescope mounted on a frame, which is held in the hand. To measure the angle between two objects, one of them is sighted directly through the telescope, and the image of the second is reflected into the telescope by means of two mirrors, one fixed rigidly to the frame in front of the telescope, and covering half its field, and the other movable around an axis fastened to the frame. The movable mirror is turned by an arm, which moves along a graduated arc on the frame, and its reading, when the two objects appear in the telescope superposed upon each other, gives the angle beteween the objects. In determining the altitude of the sun at sea the edge of the sun is made to touch the horizon; a movement of the ship moves the sun and the horizon together and the contact is not destroyed. On land, when the sea horizon is not available, a so-called *artificial horizon* must be used. The ordinary mercurial artificial

horizon consists of a flat dish about three inches wide and five or six long, filled to a small depth with mercury, the surface of which becomes perfectly horizontal. The image of the sun seen in the mercury will be as much below the horizontal plane as the actual sun is above it; and the angle between the sun and its image is twice the altitude of the sun. Except in very quiet air, the surface of the mercury must be protected from the wind by an accurately made glass cover.

The glass artificial horizon is a piece of perfectly flat dark glass, which will absorb the light which enters it and only reflect from its upper surface. It is provided with leveling screws and spirit levels so that it can be made perfectly horizontal. It is used in exactly the same way as a mercurial horizon.

Each form has its advantages; the glass horizon is easily transported, and can be used at temperatures below the freezing point of mercury (about 39° below zero Fahrenheit). On the other hand, it requires very careful leveling, and is liable to be broken. The mercury of a mercurial horizon is usually carried in an iron bottle; in pouring it back and forth it might be spilled and lost; and at very low temperatures it would be necessary to heat it to keep it liquid; but then it immediately takes a level surface and requires no leveling.

Lieutenant Shackleton, traveling over the Antarctic continent, determined his position by means of a small transit. Commander Peary and Dr. Cook, traveling over the floating ice of the Arctics, used sextants. The former used a mercurial and the latter a glass horizon.

It is interesting to note that if a man were taking an observation standing, with the sun about 6 degrees above the horizon and the artificial horizon on the level of his feet, it would have to be about 45 feet from him, and as he would look at it from an angle of about 6 degrees, it would only appear about half an inch long. If the altitude of the sun were 12 degrees, the artificial horizon would be 25 feet away and appear about an inch long. This can be easily imitated by putting a sheet of paper on the ground and looking at it from distances of 25 and 45 feet. Under such conditions the difficulties of making a good observation would be much increased. If, however, the artificial horizon were raised on a support, the observer would stand much closer to it, and the observation could be more easily made.

Another important instrument is the chronometer keeping mean Greenwich time; for, as has already been shown, the determination of position in general requires a knowledge of Greenwich time, though at the pole itself this is not necessary. Whenever an explorer remained as long as a week in one place he should determine, as well as he could, how much his chronometers were gaining or losing per day; and he should be most particular to determine the changes in their errors, between the times of leaving and returning to his base station.

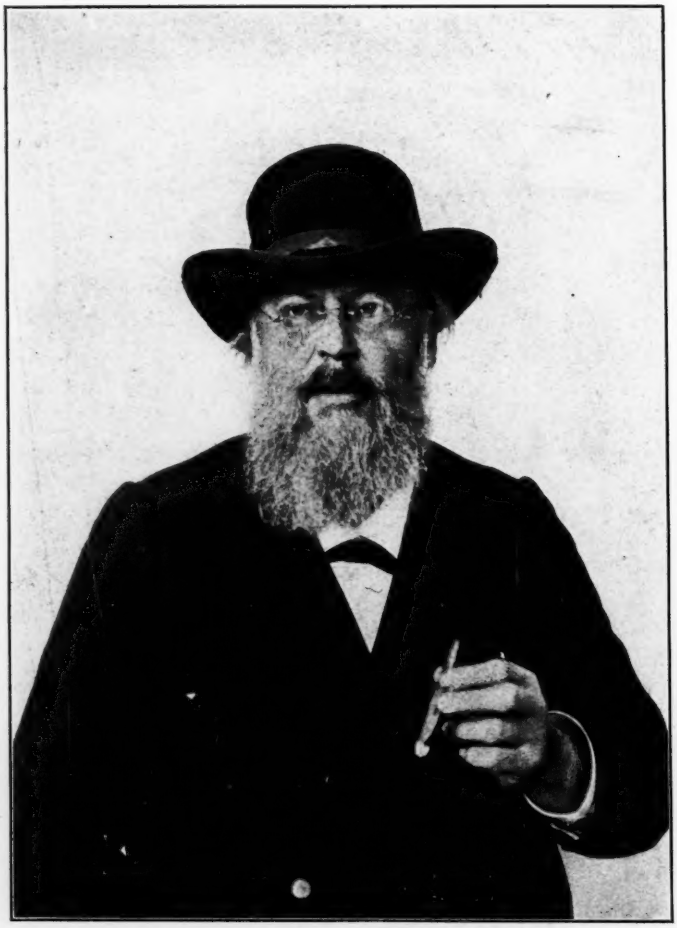
A compass is of great value to keep one's course between observations on the sun; and an aneroid barometer and a thermometer make possible a more accurate correction for refraction. A pedometer, also, or some other form of distance meter, would be useful to estimate the distance traveled.

Although the methods of determining one's geographical position would be the same near either pole, there are slight differences in their applications; for instance, the solid land of the Antarctic continent precludes drift, and therefore this disturbance is absent. Moreover, when Lieutenant Shackleton reached his farthest south in the beginning of January, 1909, the sun was about 25 degrees above the horizon; at this altitude the refraction is not large and its value is well enough known not to introduce any great error. Near Lieutenant Shackleton's base camp, at the foot of Mount Erebus, the north pole of the compass needle pointed about 30 degrees east of south. Along the most southerly part of his route, on his dash toward the pole, the north end of the needle pointed very nearly to the south pole.

On the return trip Lieutenant Shackleton could have been guided by his compass, by the mountain range which ran very nearly parallel with his route, or by other landmarks, and, perhaps, to some extent, by his tracks; so that he found it unnecessary to make many astronomical observations. Commander Peary was guided, to a great extent, on his return by his tracks and those of his supporting parties; and Dr. Cook seems to have relied entirely on his astronomical observations.

Note.—For the sake of simplicity the sun has been generally taken, in this article, as the heavenly body on which observations are made. But the stars could serve equally well, and, for some observations, better. If the pole should be approached when the stars were visible, the altitudes of two stars lying on meridians about 90 degrees apart would determine one's position without delay; moreover, stars could be selected whose altitudes were sufficiently great to exclude errors due to refraction; or this correction could be determined by observations on a pair of stars having about the same altitude and lying on opposite sides of the zenith.

The sun's apparent motion around the earth is not uniform, and therefore a correction, known as the *equation of time,* must be applied to all observations on the sun; but this correction is accurately known and leads to no error.



ANTON DOHRN.

THE PROGRESS OF SCIENCE

ANTON DOHRN, 1840–1909

In the death of Anton Dohrn zoology mourns a veteran leader, and many zoologists feel—though some of these may not have known him personally—that they have lost a genial and helpful friend. Every one knew him directly or indirectly, and one may even say that there are but few zoologists who are not in some way or another in his debt. For he founded the great station at Naples, and fostered its activities in many directions. It is no mean test of his successful management that it is supported by the funds of many nations and of many diverse institutions.

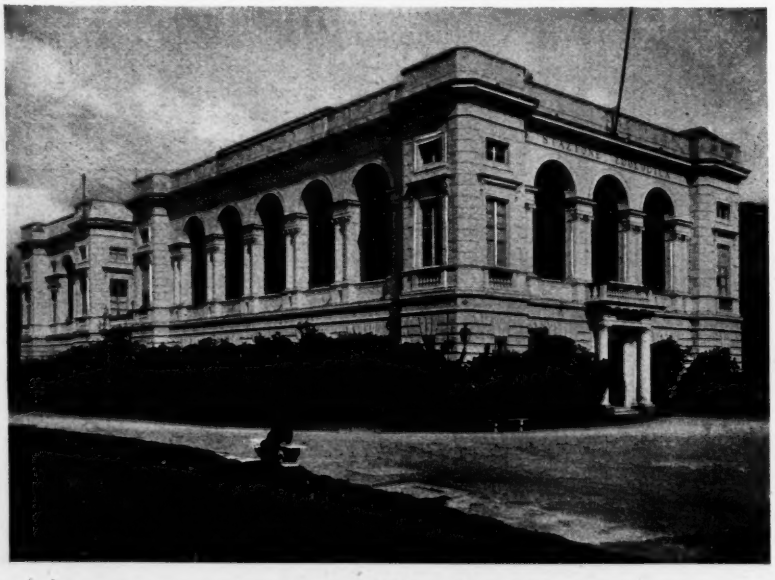
Dohrn's monument will ever be the Stazione Zoologica: its inception was his, its upbuilding, its policy and its completion—if such a work can ever be called completed. From the time of his early studies—while indeed he was in Messina, in the sixties—he had ever before him the vision of a completed zoological station, an international one, vast in size, splendid in equipment. And with prophetic eye he selected Naples as the field of his life-work. He soon found that his project was not an easy one to carry out, especially in days when sea-side laboratories were rare and obscure, and when indeed zoology had hardly come to its own in the scheme of sciences. But Dohrn surmounted the difficulties, scientific, political and financial. In the last regard, when the Academy of Berlin failed to endorse his project, he showed to friends and enemies his faith in his convictions by putting his personal funds, almost all of them, into the melting pot. In the end his arguments were so convincing that the German government granted him a handsome annual subsidy, and insured the success of his undertaking.

Dohrn's history can here be given only in the briefest lines. He was born in 1840, the son of a North German Fabrikbesitzer of scientific tastes. He became a student of Schnell in Jena, devoting himself especially to the study of the arthropods. He was appointed privat-docent; then he traveled, theorized and wrote, but he taught little; apparently he did not care for the class-room, and even at the end he could point to but few whom he had directly trained. At the outbreak of the war of 1870, Dohrn became a soldier and fought through the campaign; then he returned to his great plan of the stazione and his struggles in its behalf. The opening of the first building was in 1874, the publications (Mittheilungen and Memoirs) of the station began in 1879, the second building was completed in 1890, the third building (for physiology) in 1907. Through all these years he continued his difficult researches, publishing his results in a series of memoirs. From the first to the last Dohrn showed a rare many-sidedness; to many he was ever the genial friend, to a few the explosive and repentant enemy; at one moment he was the tactful executive, at another the amateur of music and art, at all times the idealist and the profound and conscientious scholar, ever ready (*too* ready some said) to accept the evidence of facts and to change his scientific views. He had qualities, all in all, which made him a personage of first magnitude in the annals of zoology.

Dohrn's activities in research could readily be made the theme of a volume. For he was a tireless worker and his publications touch many of the most important problems of his day. His earlier years were spent in the study of the embryology of the arthro-

pods (1858–81): of this period is to be mentioned his beautiful monograph on the pantopods. In 1875 appeared his paper "On the Origin of the Vertebrata and on the Principle of the Change of Function"; it was a small brochure, but it touched with a master's hand some of the great problems of its day. This paper Brooks declared should be read by every one of his pupils before he would give him his doctorate—this in spite of Brooks's lack of sympathy with the tenets which Dohrn had laid down. It was this paper which paved his way for researches which were to extend over a third of a century. And one may follow the development of the subject—and of Dohrn himself—in a series of twenty-five voluminous memoirs.

It was the "momentous problem of the beginnings of the back-boned animals" which Dohrn sought to solve. And upon this matter his writings are encyclopedic. Vertebrates were to him descendants of chætopod worms; their typical organs did not arise *de novo* but as transformations of organs having a different function; animals of simple structures were not as often primitive as Haeckel, for example, would teach, but were frequently degenerate; Amphioxus and Ascidians were not in the line of descent of the higher vertebrates, nor were lampreys —the latter were rather degenerate bony-fishes. In his early papers his readers are carried along on the crest of a splendid wave of enthusiasm. "The problem is solved, . . . all but solved, . . . soon to be solved." But this stage of conviction comes to pass darkly into the background, new difficulties keep appearing, and in later papers one hardly realizes the genetic bearing of the data which Dohrn is bringing together. The method of the paper of 1875, which was essentially deductive, gradually gave place to an elaborate inductive method; separate organs of the vertebrata are studied in turn, especially in the head region, and the difficulties are traced gradually into finer and finer ramifications, until in the end he deals with what appears to be purely the puzzle of nerve histogenesis. For Dohrn would not admit that the head problem in the vertebrate was not to be solved with the present materials or by the aid of the embryo-



THE NAPLES ZOOLOGICAL STATION.

logical method; and one feels that he kept hoping against hope that some clue would yet be found to lead him triumphantly out of his labyrinth of difficulties. So he held fast to his plan of research, undismayed when his fellow workers deserted him. "The problem is difficult, not dead," he is said to have declared, when others entered some new and attractive field—"and it is in the difficulties of an old problem that one learns, not in beginning a new one."

Dohrn suffered, there can be no doubt, in noticing that as time went on "the problems of the head" attracted fewer workers. But such a man must have realized, none the less, that this was an inevitable result when new lines of investigation are suddenly developed and when the number of investigators available for all fields is small. And in his heart he must have felt that his theme would always be given a high place, even by those to whom it became "unfashionable." On the other hand if there was no general sympathy for his embryological work there was certainly no lack of appreciation of his work for the Naples station. He lived to see it in the position which he had planned for it, and he took keen satisfaction in seeing his son Reinhart installed as its executive. So he may well have felt in the end, as the solace of his long illness, that his work had been well done.

THE NON-MAGNETIC YACHT "CARNEGIE"

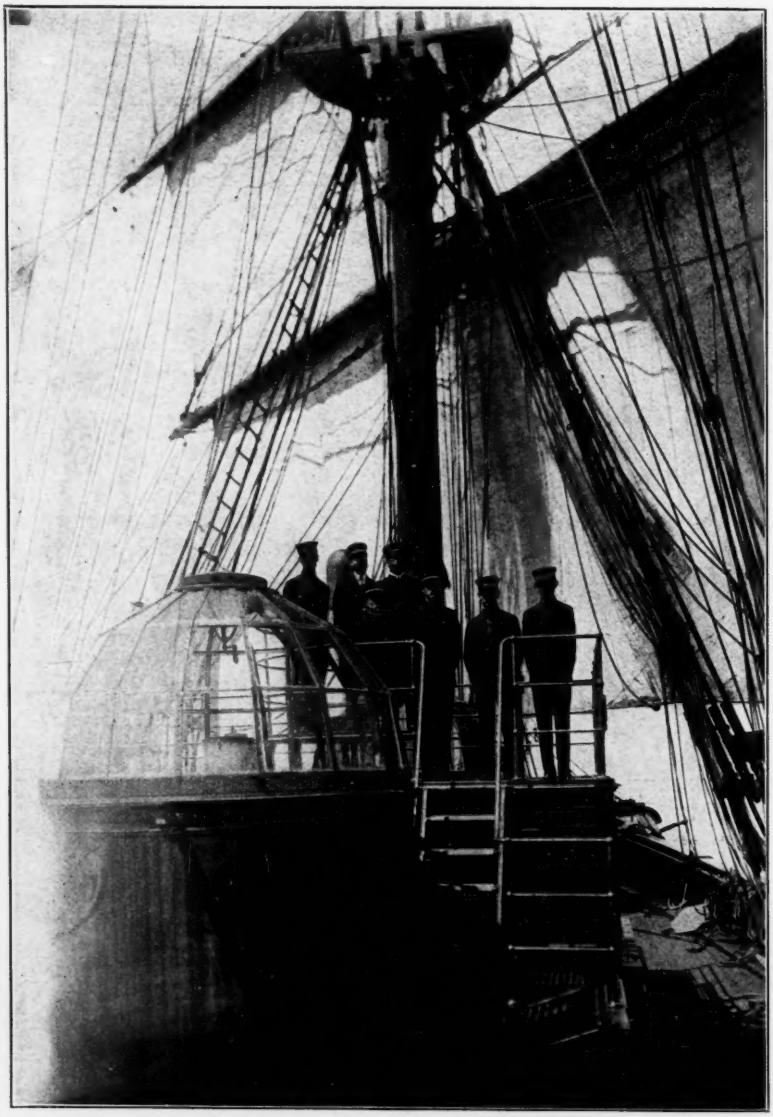
THE *Carnegie* left Brooklyn, N. Y., on August 21 last, to carry out her first cruise, extending to St. John's N. F., thence to England and returning to New York, early next year, *via* Madeira and Bermuda. As may be recalled, this vessel has been built practically without any iron, or other magnetic materials, in order to adapt her to the needs of a magnetic survey of the oceans under the direction of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

She arrived at St. John's on September 25 and left again on October 2 with the director, Dr. L. A. Bauer, on board, accomplishing the passage across the Atlantic to Falmouth, England, in twelve days. She is now *en route* to Madeira and Bermuda under the command of W. J. Peters. In addition to the scientific and navigation staff, composed of seven persons, there are on board two watch officers, two cooks and nine seamen, or twenty persons in all.

The tests and observations made thus far have proved that the desired non-magnetic conditions where the various instruments are placed have been actually secured, so that no corrections whatsoever need be applied to the magnetic data obtained on the *Carnegie*. In consequence the work has been greatly facilitated and for the first time it has become possible to make known the results immediately upon conclusion of a voyage. The instruments, largely designed and constructed in the workshop of Dr. Bauer's department, have reached a high stage of perfection, permitting satisfactory observations to be made even under adverse conditions of sea and weather.

The introduction of sheltering observatories, circular in shape and having revolvable domes similar to those of astronomical observatories, is one of the new features which has contributed to the success achieved. Inside these observatories, of which there are two, the after one being shown in the view, both astronomical and magnetic observations may be made with full protection to the observer and instrument from wind and weather.

During a period of six weeks the work of this vessel has already disclosed errors in the magnetic data supplied to mariners of sufficient practical importance to require attention. Thus it was found that from Long Island to a point off St. John's the charts show too small west magnetic declination by



THE "CARNEGIE."

amounts running up to one degree and a half, *i. e.*, the compass was found to point farther to the west of north than indicated by the charts. On the portion of the trip from St. John's to Falmouth, an error in the reverse direction was revealed, showing that the compass did not, in general, point as far west as given by the mariner's charts—the errors almost reached a degree.

The effect of these chart errors, on account of their systematic and peculiar run, is to set both inward- and outward-bound vessels towards Sable Island or Cape Race whenever sole reliance must be placed upon the compass, as is the case when no sun or

stars may be sighted. It appears that captains have been aware of these systematic errors and have learned how to make allowance for them, but their precise cause has not been known until this work of the *Carnegie*.

Another feature in which considerable interest attaches is the development of the producer-gas engine for the purposes of auxiliary marine propulsion. The *Carnegie* is said to be the first sea-going vessel equipped with such a plant. Her engine is of 150 horse-power, sufficient to drive her six knots in calm weather and give her a cruising radius of 2,000 miles with a coal consumption of but 25 tons, or at a cost of about $100.

THE CONVOCATION WEEK MEETINGS AT BOSTON

THE American Association for the Advancement of Science and the national scientific societies affiliated with it will meet at Boston, beginning on December 27. There is good reason to look forward to a meeting of unusual interest, perhaps to the largest and most important scientific gathering in the history of the country. In the summer of 1898 the American Association celebrated at Boston the fiftieth anniversary of its foundation with 903 members in attendance, almost the largest meeting up to that time, the largest having also been held in Boston —in 1880—with an attendance of 997. In 1898 the membership of the association was 1,729; it is now over 8,000. In the meanwhile, beginning with the Washington meeting of 1902–3, the convocation week meetings have been organized, and the national scientific societies devoted to the natural and exact sciences meet together during the week following Christmas. The attendance of scientific men at these meetings has been in the neighborhood of two thousand, and the number of scientific papers presented has approached a thousand. The meeting has become more technical in character, and it seems that the interests of those not professionally engaged in scientific work have been somewhat neglected. At the Boston meeting, however, it is proposed to leave the special papers to the special societies, while the association and its twelve sections will present programs of general interest.

Dr. T. C. Chamberlin, of the University of Chicago, eminent as a geologist and for his services to education, will, as retiring president, give the annual address on the evening of Monday, December 27. The address will be at the Sanders Theater, Harvard University, and will be followed by a reception in Memorial Hall. The vice-presidential addresses will be given by Professor Keyser, of Columbia University; Professor Sumner, of Yale University; Professor Herrick, of the University of Chicago; Professor Guthe, of the University of Michigan; Professor Richards, of Columbia University; Professor Kahlenberg, of the University of Wisconsin; Professor Howell, of the Johns Hopkins University; Professor Swain, of Harvard University; Professors Dewey and Woodworth, of Columbia University. All these addresses should be of interest to a wide audience, and each section is expected to arrange a discussion or series of papers that will not be technical in character.

The special societies meeting at Boston cover practically the whole range of the natural and exact sciences. The American Society of Naturalists has this year arranged a program devoted to problems of experimental evolution, which includes papers by the leading workers in this subject. The address of the president, Professor T. H. Morgan, of Columbia University, is on "Cause or Purpose in the Evolution of Adaptations." The American Chemical Society, which is the largest of the special societies, must be divided into numerous sections for the reading of papers. There are, however, general sessions, before one of which Dr. Whit-

ney, of the General Electrical Company, will give the presidential address on the chemistry of artificial light. The mathematicians, the physicists, the geologists, the paleontologists, the biological chemists, the physiologists, the anatomists, the bacteriologists, the zoologists, the entomologists, the botanists, the anthropologists, the psychologists and other groups will hold meetings whose programs would fill many pages.

The railways have allowed the usual reduction in rates on the certificate plan. Apart from scientific programs of unusual attractiveness the educational and other institutions of Boston can under such circumstances be visited to special advantage. Those who are professionally engaged in scientific work and those who are interested in following the progress of science can to equal advantage be present at Boston during convocation week.

SCIENTIFIC ITEMS

THE Nobel prizes for the present year have been awarded as follows: For Physics—Divided between Mr. Guglielmo Marconi and Professor Ferdinand Braun, of Strassburg. For Chemistry —Professor Wilhelm Ostwald, of Leipzig. For Physiology or Medicine—Professor Theodor Kocher, of Berne. For Literature—Selma Langerlof, the Swedish authoress. For the Promotion of Peace—Baron D'Estournelles de Constant, president of the French parliamentary group for international arbitration, and M. Beernaert, former Minister of State of Belgium.

THE Royal Society has awarded its Copley medal to Dr. G. W. Hill, of Nyack, N. Y., for his researches in mathematical astronomy; royal medals to Professor A. E. Love, for his researches in the theory of elasticity and cognate subjects and to Major Ronald Ross, for his researches in connection with malaria; the Davy medal to Sir James Dewar, for his researches at low temperatures, and the Hughes medal to Dr. R. T. Glazebrook, for his researches on electrical standards.

THE Philosophical Society of Washington held on December 4 a meeting commemorative of the life and services of Professor Simon Newcomb, late president of the society. The program included addresses by the Honorable James Bryce, Dr. Milton Updegraff, Dr. R. S. Woodward, Dr. L. O. Howard and Dr. E. M. Gallaudet.

AT the recent meeting of the board of trustees of the Carnegie Foundation for the Advancement of Teaching, Dr. Ira Remsen, president of Johns Hopkins University, and Dr. Charles R. Van Hise, of the University of Wisconsin, were elected trustees to fill vacancies caused by the resignations of Dr. Charles W. Eliot, of Harvard University, and Dr. E. H. Hughes, of De Pauw University. Provost Charles E. Harrison, of the University of Pennsylvania, was elected chairman of the board to fill the vacancy caused by the retirement of Dr. Eliot.

BY the will of the late George Crocker, of New York City, valuable property, said to be worth about $1,500,000, has been bequeathed to Columbia University for researches on the cause, prevention and cure of cancer.—The board of trustees of the Reed Institute will establish at Portland, Ore, a College of Arts and Sciences, with the bequest of $2,000,000 left by the late Mrs. Amanda W. Reed.